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A

SYSTEM OF

SURGERY;

PATHOLOGICAL, DIAGNOSTIC, THERAPEUTIC, AND OPERATIVE.

BY

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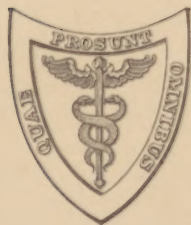
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UPWARDS OF SIXTEEN HUNDRED ENGRAVINGS.

SIXTH EDITION,

THOROUGHLY REVISED AND GREATLY IMPROVED.

IN TWO VOLUMES.

VOL. I.

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1882

TO

THE NUMEROUS PUPILS

WHO, DURING NEARLY HALF A CENTURY,

ATTENDED HIS LECTURES,

AND WHO ARE NOW SETTLED IN EVERY SECTION OF THE UNITED STATES, AS WELL AS

IN MANY FOREIGN LANDS,

IN THE

HONORABLE PURSUIT OF THEIR PROFESSION,

𝕿𝖍𝖊𝖘𝖊 𝖁𝖔𝖑𝖚𝖒𝖊𝖘,

DESIGNED TO ILLUSTRATE ONE OF THE MOST IMPORTANT AND VALUABLE BRANCHES OF
THE HEALING ART,

ARE RESPECTFULLY AND AFFECTIONATELY INSCRIBED

BY THEIR FRIEND,

THE AUTHOR.

A certis potius et exploratis petendum esse præsidium; id est, his quæ experientia in ipsis curationibus docuerit; sicut in cæteris omnibus artibus; nam ne agricolam quidem aut gubernatorem disputatione, sed usu, fieri.   CELSUS.

He—the surgeon—should be courteous and condescending, bold in security, cautious in time of danger, avoiding impracticabilities, compassionate to the infirm, benevolent to his associates, circumspect in his prognostication, chaste, sober, pious, and merciful, not greedy of gain, no extortioner, but looking to his fee in moderation, according to the extent of his services, the ability of his patient, the result of his treatment, and a proper sense of his own dignity.

GUY DE CHAULIAC.

We may not only rank Chirurgery among the Sciences; but look on it as one of the noblest, most certain, and most necessary of them all.   DIONIS.

The nobility and dignity of Chirurgery are too well known to want the help of an oratour to set them forth. If a panegyrick were necessary, it were best made by running through the particulars of the art, and the history of the diseases cured thereby.   WISEMAN.

PREFACE.

The object of this work, as set forth in the first edition, issued in 1859, is to furnish a systematic and comprehensive treatise on the art and science of surgery, considered in the broadest sense; one that shall serve the practitioner as a faithful and available guide in his daily routine of duty. My aim has been to embrace the whole domain of surgery, and to allot to every subject its legitimate claim to.notice in the great family of external diseases and accidents. If a larger space than is customary has been devoted to the consideration of inflammation and its effects, or the great principles of surgery, it is because of my conviction, founded upon long and close observation, that there are no subjects so little understood by the general practitioner. Special attention has also been bestowed upon the discrimination of diseases; and an elaborate chapter on general diagnosis has been introduced.

The work, although presented, as its title indicates, as a formal and systematic treatise, is founded upon the courses of lectures which it devolved upon me to deliver during the last forty-two years; first in the University of Louisville, for a long time the most flourishing medical school in the Southwest, and during the last twenty-six years in the Jefferson Medical College, from which, in 1828, I received my degree. During all that period, I was unceasingly devoted to the duties of an arduous practice, both private and public; to the study of the great masters of the art and science of medicine and surgery; and to the composition of various monographs which had a direct bearing upon a number of the subjects discussed in these volumes. The work should, therefore, be regarded as embodying the results of a large personal, as well as of a ripe, experience, of extensive reading, and of much reflection; in a word, as exhibiting surgery as I myself understand it, and as I, for so many years, conscientiously taught it.

The favor with which the work has been received is sufficiently attested by the exhaustion of five large editions, by its translation into the Dutch language, and by the universal commendation bestowed upon it by the periodical press, both at home and abroad. This evidence, so gratifying to my feelings as an author, instead of abating my ardor, has only served to stimulate me to

increased exertion to render the work still more useful as a faithful exponent of the existing state of the art and science of surgery.

Upon the edition now issued much time and labor have been expended, rendered necessary by the astonishing progress made during the last ten years in every branch of surgery. Every chapter has been thoroughly revised, many portions have been entirely rewritten, and a large amount of new matter has been introduced, in order to place the work fully abreast of the existing state of our knowledge. To impart completeness to my labors, in every respect most arduous and perplexing, I have freely availed myself of the assistance of Professor S. W. Gross, whose pen and judgment have been of the greatest service to me in supplying deficiencies, especially in relation to morbid growths, in collecting statistics, and in correcting the press. To Dr. J. Solis Cohen, Dr. George C. Harlan, and Dr. Charles H. Burnett my thanks are due for aid received in revising, respectively, the chapters on the Respiratory Organs, the Eye, and the Ear. The section on Refraction and Accommodation of the Eye, written for the fifth edition by Dr. William Thomson, Professor of Ophthalmic Surgery in the Jefferson Medical College, is retained nearly in its entirety. Professor Edward C. Seguin, of New York, has kindly furnished the section on Cranio-Cerebral Topography, the first attempt, as far as I know, to introduce matter of this kind into a work on surgery. Dr. Battey has kindly supplied me with valuable matter relative to Oöphorectomy, and Dr. Lewis Hall Sayre relative to the application of the plaster-jacket in the treatment of spinal diseases. To Dr. Barnes, late Surgeon-General of the United States Army, I am under obligations for many of the cuts which illustrate the subject of Gunshot Wounds. The elaborate index has been kindly prepared by Dr. Richard J. Dunglison, whose labors in the interests of American medical literature are so well known.

Of the engravings which accompany the volumes upwards of six hundred are original. The remainder have been copied from the large collection in the possession of the publishers, due credit having been awarded in every instance to the original source when it could be satisfactorily ascertained. Messrs. Gemrig and Kolbé, of this city, and Messrs. Tiemann & Co., of New York, have supplied me with numerous engravings illustrative of the latest improvements in surgical instruments, apparatus, and appliances.

In taking a retrospect of the last fifteen years one cannot fail to be struck with the extraordinary strides which surgery has made during this brief but prolific period in the world's history. Much of this progress is unquestionably due to the foundation which Dr. Ephraim McDowell unconsciously laid when, in December, 1809, he performed his first operation for the removal of a diseased ovary. To that operation, in the bold hands of the two Atlees, Clay, Wells, Kimball, Dunlap, Keith, Péan, Schroeder, Koeberlé, Thomas and others,

are directly due the brilliant advances which have been made in abdominal and pelvic surgery during this time. To Professor Lister must be accorded not a little praise for the part he has played in this wonderful work. If only one tithe be true of what his admirers claim for him, enough remains to entitle him to the credit of being one of the world's eminent benefactors. It was he who first taught surgeons the importance and value of thorough cleanliness in their operations and dressings, before his time so little understood and so seldom practised. Specialism, too, is entitled to undying praise. It has penetrated with its methods and instruments of research the innermost recesses of the human body, and has achieved, in a comparatively brief period, triumphs which general surgery could not have achieved in half a century, if, indeed, ever. Operative surgery is rapidly advancing towards its finality of perfection; surgical pathology, under the influence of the cell-doctrine and of the plastic genius of Paget, Virchow, Billroth, and others, has been placed upon a permanent basis; and therapeutic surgery was never in so healthful a condition as it is at the present moment. The world abounds in great surgeons, men accomplished in the science, and skilled in the art of healing, capable of interpreting the secrets of pathological processes, of diagnosticating disease, and of performing with ability and readiness all the great operations, formerly the province of a favored few. The time has gone by when any one practitioner can boast of a monopoly of skill or of reputation in this or in that field of surgery; all have a hand in it, although some are greater and wiser and more competent than others. In the marvellous revolution now in progress, it is gratifying to find that American surgery is fully abreast of the surgery of other nations.

S. D. GROSS.

JEFFERSON MEDICAL COLLEGE,
PHILADELPHIA, October, 1882.

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A

SYSTEM OF SURGERY.

CHAPTER I.

IRRITATION, SYMPATHY, AND IDIOSYNCRASY.

It is very difficult, if not impossible, in the present state of the science, to offer any satisfactory definition of irritation, or to assign to this expression its true pathological and practical import, without an intimate knowledge of sympathy or of those various and mysterious relations, anatomical and functional, which exist among the different organs and tissues of the body, and which thus serve to bind them all up into one harmonious, uniform, and connected system. Irritation and sympathy are not only closely associated together, in all the great operations of the economy, but they so constantly run into each other as to render it impossible always to draw a precise line of distinction between them, or to determine what part they respectively play in the production, propagation, and effect of disease. Much of what has been written upon these topics has necessarily been exceedingly obscure, depending not merely upon the intrinsic difficulties of the subject—great and perplexing as they certainly are—but upon the unphilosophical manner in which they have, for the most part, been discussed by surgeons, whose authority has not only never been disputed, but regarded with a blind devotion as surprising as it has generally been unaccountable. To arrive at any other conclusion from an attentive perusal of their writings, is impossible. Every page, nay, almost every paragraph, bears testimony to the fact that they have constantly confounded together affections of a very different, and even of an opposite nature ; that they have, in numberless instances, violated their own definitions of disease ; and that they have attempted to establish systems of treatment based upon principles of the most erroneous and unfounded character.

What is irritation? Is it an entity or a mere myth, a certain undefinable something, which no one can see, but which every one may recognize by its effects? Perhaps the best definition that can be given is that it is a disordered state of the nerves of the affected part, attended with more or less pain and functional disturbance, but not with inflammation, although it may lead to inflammation, if not timeously arrested : in other words, irritation is a disease the predominant symptom of which is nervous derangement. Viewed in this light, it may be considered as holding the same relation to the nervous system that inflammation bears to the vascular ; the one consists essentially in disordered sensation, the other in disordered circulation ; in the one there is pain, but it is the pain of perverted sensation ; in the other there is pain also, but it is the pain of inflammation, as is evinced by the concomitant vascular injection, discoloration, and tumefaction, which are wanting in the former. The differences between irritation and inflammation have sometimes been defined by stating that the former terminates where the latter begins ; as congestion may be said not to be inflammation, but the prelude to that affection. Both may be merged in the latter disease, and may, consequently, serve to augment and perpetuate it.

Irritation may be of limited extent, as when it is confined to one particular organ, or part of the body, and is then said to be local ; on the other hand, it is sometimes widely diffused, manifesting itself at numerous points, and constituting what is termed general

irritation, of which one of the most familiar illustrations occurs in nervous shock, conse-
quent upon severe injury. It is also divided into direct and indirect; in the former case,
the irritation displays itself at the place of the morbific impression; in the latter, on the
contrary, it occurs at a situation more or less remote, sympathy and reflex action being
the agents of its transmission. An example of direct irritation is afforded in the intole-
rance of light which results from over-fatigue of the eye: and of the indirect, in the con-
vulsions which supervene upon the presence of worms in the alimentary canal, the irrita-
tion being communicated here from the nerves of the bowels to the spinal cord, or the
cerebro-spinal axis, and from thence to the nerves of the voluntary muscles, the seat of
the spasmodic action.

Local irritation may manifest itself in a great variety of ways and circumstances. It
is generally excited by the contact of some extraneous substance, or agent, foreign to the
part, and, therefore, a source of offence to it. Thus a drop of alcohol, falling upon the
eye, instantly produces pain, and injection of the conjunctiva, with an abundant flow of
tears; the organ resents the aggression, and the consequence is a marked perversion both
of sensation and circulation, which, the exciting cause ceasing to operate, soon passes off,
the parts regaining their comfort and accustomed action; or, the cause continuing in play,
violent and even destructive inflammation may succeed, the minor evil being merged into
the major. A pinch of snuff will excite sneezing by the irritation which its presence
induces in the pituitary membrane; on the same principle, some emetics cause vomiting,
some cathartics purging, and some diuretics an increased secretion of urine. When the
hand is held near a hot stove, or rubbed with spirits of ammonia, the skin presently shows
signs of irritation: its sensibility is perverted, it burns and stings, and becomes intensely
red. All these, and numerous analogous cases that might easily be adduced, if it were
necessary, are examples of local irritation, or of perverted nervous action, accompanied
by vascular determination, but not by inflammation, although such an event is certain to
occur, if the exciting cause of the irritation be not promptly removed.

Indirect, or reflex irritation, like the direct, also displays itself in different ways, and
not unfrequently in a manner not less singular than perplexing, defying all effort at expla-
nation. The subject offers a wide field for contemplation and study. Here I can only
glance at a few of the more prominent facts which naturally connect themselves with such
a discussion. To do anything even like partial justice to the subject, it will be proper to
consider it in relation to the principal organs of the body, a procedure which will neces-
sarily bring up the question of sympathy, as a knowledge of the latter is indispensable to
a correct appreciation of the former, and conversely.

It would be out of place in a work of this kind to inquire into the nature of sympathy.
All that we know respecting it is that there exists, both in health and in disease, an inti-
mate relationship between certain organs and tissues, the result either of a continuity of
structure, similarity of tissue, or of ties, of which anatomy and physiology have failed to
point out the true character. In health, this action is carried on so imperceptibly as to
escape attention; but, whenever there is any serious disorder of the system, it manifests
itself at every point, serving at once, at least in many cases, to indicate the nature of the
lesion, and the particular tissues, or set of textures, which it implicates. It is not difficult
to account for the sympathy that exists between parts that are united together by con-
tinuity of structure, as, for instance, the eye and nose, or the bladder and urethra; or by
similarity of structure, as the fibrous membranes, the diseases of which, as gout and rheu-
matism, are sometimes suddenly transferred from one to another: but in other cases—and
these constitute some of the most interesting and important exceptions—no connection of
any kind can be traced, and we are therefore left in doubt in respect to its real character.
It is only, then, by studying these effects, as they exhibit themselves in different parts of
the body, and under different circumstances, that our knowledge of them can be made
practically available.

1. *Nervous System.*—The brain, from its elevated position in the scale of organs, and
its importance to health and life, is subject, in a remarkable degree, to the causes which
develop and influence irritation. Connected, either directly or indirectly, with every
other organ and tissue of the body, its functions are liable to be disturbed in every variety
of way, and in every possible degree, from the most simple and almost imperceptible
departure from the normal standard to the most complete and thorough perversion, amount-
ing, at times, to total annihilation of sensation. Hence, it is not surprising that while the
brain is itself a source of irritation to other parts, it should in its turn, be more or less
seriously affected by irritation having its seat in remote structures operating upon it through

sympathy, or reflex action. It is in this manner that are developed many of the most distressing diseases of the cerebrum and cerebellum, and also, as a natural consequence, of the mind; and what is remarkable is, some of the most disastrous lesions often have their origin in apparently the most trivial cerebral irritation, which, but for neglect or ignorance, might usually be relieved by the most simple treatment. The arachnitis of infancy generally begins in reflex irritation, which has its seat in the bowels, stomach, liver, skin, or gums, fretted, perhaps, by the pressure of an advancing tooth. Such cases are of constant occurrence in this country, during our hot summer months, and there are none which are more justly dreaded by the practitioner. The influence of this kind of irritation is often forcibly exhibited in traumatic delirium, or that excited state of the brain consequent upon accidents and operations, especially in subjects of intemperate habits and of a nervous temperament; the brain appears to be in a state of the utmost tension from pent-up irritability, which nothing but the most liberal use of anodynes can generally control; all the symptoms are such as to preclude the idea of the existence of inflammation in the cerebral substance, nor is it by any means certain that there is always gastritis, although usually there is marked derangement of the stomach. In disorder of the uterus, the brain is often affected by reflex irritation, as is plainly evinced by the eccentric phenomena which so generally attend hysterical diseases.

On the other hand, disease of the brain is often productive of serious irritation, or disease in other parts. Thus, after concussion of this organ, it is by no means uncommon, after the main symptoms of the accident have subsided, to meet with paralysis of one side of the face, occasional vomiting, constipation of the bowels, irritability of the bladder, or disease of the sphincters, causing involuntary discharges of urine and feces.

The sympathies existing between the cerebellum and the testes afford a ready explanation of the occurrence of certain diseases, which, but for a knowledge of this fact, would be inexplicable. Military surgeons long ago noticed that wounds of the occiput, even when not involving the substance of this portion of the brain, are often followed, at variable periods after recovery, by atrophy of the testicles. Injuries of the cerebellum have been known to be succeeded, within a short time after their infliction, by the most violent sexual excitement. A case of gunshot wound, in a man twenty-five years of age, related to me by Dr. Donne, admirably illustrates the nature of such a lesion. The ball, a common rifle one, penetrated the skull near the lambdoidal suture, whence it passed obliquely downwards and backwards, lodging, there was every reason to believe, in the cerebellum. The reaction, which was very slow, was attended with excessive excitement of the genital organs. Intense priapism supervened on the fifth day, attended with the most extraordinary salacity, which formed the all-absorbing topic of the man's remarks during his semilucid intervals up to the time of his death, nine days after the receipt of the injury. Nocturnal pollutions and the habit of onanism, in their most degrading forms, are often excited and kept up by a diseased state of the brain operating prejudicially upon the testes and seminal vesicles. The effect may be produced simply by inflammation of the cerebral tissues, or by the pressure occasioned by some morbid growth, as a sarcomatous, scrofulous, or other tumor.

The study of the sympathies and irritations of the *spinal cord* naturally follows that of the brain. Connected, as this cord is, on the one hand, by the nerves which are detached from its substance, with the organs of volition and of special sensation, and, on the other, by the anastomoses of these same nerves with those of the great trisplanchnic system, its sympathies and relations are as universal as they are close and intricate. Hence whatever has a tendency to derange these consentaneous movements, must necessarily be a source of disease, often of a wide-spread, if not of an all-absorbing character. Concussion, for example, of the spinal cord, when not immediately followed by death, is generally productive of excessive prostration of the vital powers, hardly less extensive and fatal than that of the brain itself. Life often hangs literally for hours upon a mere thread; the face is ghastly pale, the pulse weak and fluttering, the breathing hardly perceptible. In the milder forms, the mind is frequently disordered for days, the bladder is excessively irritable, the bowels are costive, the eye sees objects confusedly, and the ear is incapable of accurately noting sound. There are many diseases which may induce spinal irritation; I shall allude only to inflammation, ulceration, and displacement of the uterus, the practice of self-pollution, constipation of the bowels, and chronic gastric disorder. On the other hand, spinal irritation is capable of sending its baneful influence through every portion of the system, deranging the functions of every organ, and causing a train of phenomena frequently as distressing as they are enigmatical, or difficult of interpretation. Nervous headache, hemicrania, partial paralysis, imperfect sight, partial

aphonia, embarrassed respiration, palpitation of the heart, gastric irritation, vitiated appetite, costiveness, and disorder of the menstrual secretion, are often directly traceable to disease of the spinal cord and its envelops; and no practitioner can make much progress towards a cure in these affections without bearing in mind the sources whence they spring. The renal secretion is often greatly deranged by disease and injury of the spinal cord, and a very common effect of such lesions is a tendency to various deposits, especially the lithic and phosphatic. The bladder is also liable to suffer under such circumstances; becoming irritable, inflamed, and the seat of calculus, especially when the spinal cord has been severely concussed, wounded, or compressed. Many cases of neuralgia, gout, and rheumatism owe their origin, there is reason to believe, to disorder of the spinal cord, or the spinal cord and brain.

The *nerves*, those agents which convey to and from the brain and spinal cord the impressions made upon the various organs of the body, are themselves not unfrequently the seats of serious diseases and injuries, serving to modify and pervert their functions. A spicule of bone, a ball, or the point of a needle, pressing upon a nerve, or partially imbedded in its substance, has often been productive of epilepsy, partial paralysis, loss of sensation, and other unpleasant symptoms, which promptly vanished upon the removal of the foreign body.

2. *Heart.*—As the heart is sympathetically connected with every portion of the body, so there are few diseases which are not capable of exerting a prejudicial influence upon its action, exalting it at one time and depressing it at another. It may be irritated and fretted in a thousand different ways; now by this cause, and now by that; at one time by the solids, and at another by the blood, its natural and proper stimulus. Both the surgeon and physician daily witness examples of these disturbing agencies, and prepare to meet them by the judicious exercise of their clinical knowledge, often sadly tried by the perplexing and dangerous features of the case. There is no organ, the brain hardly excepted, the action of which varies so much as that of the heart within the limits of health, and none which suffers more frequently and profoundly in disease and accident. The blood which, on the one hand, serves to animate and rouse it, and which, on the other, it is obliged at every moment to propel to every portion of the body, is itself one of the greatest sources of irritation to which it is so constantly exposed. At one time the cause of the irritation perhaps is plethora, at another anemia; in one case it may be due to an undue proportion of saline matter, in another to the presence of some extraneous substance. Among the more prolific sources of cardiac irritation are disorder of the digestive apparatus, mechanical obstruction to the circulation, however induced, mental emotion, and derangement of the liver, uterus, and kidneys.

In injuries, derangement of the sympathetic relations of the heart is of constant occurrence, exhibiting itself in various forms and degrees, from the slightest disorder of its functions to almost complete annihilation of its muscular powers. In shock, the pulsations of the heart are weak and fluttering; in compression of the brain, slow and laboring; in hemorrhage, thrilling and vibratory; in plethora, strong and full; in anemia, quick, jerking, and accompanied with a peculiar systolic murmur.

Irritation of the heart is often aroused by compression of the cardiac nerves by various kinds of tumors, by aneurism of the great vessels, and by diseases resident in its own tissues, causing them to act in an irregular and imperfect manner.

As the heart's action may be disordered by various diseased states of the body, so may this organ, in its turn, occasion derangement and irritation in other structures, leading not unfrequently to violent inflammations which no remedial measures, however judiciously applied, can always arrest and subdue. These disordered states form a wide field of study, which it would be out of place to pursue in a work of this kind. The intelligent reader will not fail to appreciate their pathological and practical import.

3. *Lungs.*—The action and reaction which are so incessantly going on between the lungs and the rest of the system cannot fail to strike the most superficial observer. From the importance of their functions, and their extensive sympathetic relations, these organs are subject to numerous and diversified changes, the influence of which, upon the general health, can only be duly estimated by a profound study of the subject. Whatever seriously affects the functions of the more important structures, is sure, sooner or later, to exert an unfavorable impression upon the lungs, disordering the respiratory movements, and untowardly interfering with the aeration of the blood, or the introduction of oxygen, and the elimination of carbonic acid. Hence, a perfectly healthy state of these organs is

a matter of paramount importance in the treatment of every case of injury and disease. Among the more common objects of attention, with this view, should be a pure state of the atmosphere, the use of wholesome food, and the correction and improvement of the secretions, without which our best directed efforts will often fail to avert irritation and disease, or to combat them successfully when their development has been unavoidable.

4. *Digestive Organs.*—The *stomach*, possessing a wide range of sympathy, is often the seat, not less than the cause, of severe irritation. Food and drink are the natural stimulants of this organ, and, rationally employed, seldom prove unwholesome. But when the laws of digestion are contravened by dietetic debauch and indiscretion, or, in other words, when the stomach is overloaded with indigestible articles, nausea and vomiting, with more or less cerebral and other disturbance, are the necessary and inevitable consequences. In children and delicate nervous females, such abuse often manifests its effects in the most violent convulsions, from the irritation it produces in the cerebro-spinal axis and the nerves which are distributed to the voluntary muscles. An over-loaded stomach frequently brings on a severe attack of asthma, palpitation of the heart, indistinctness of vision, and distressing noises in the ears.

Affections of the *œsophagus* often create excessive irritation of the stomach, manifesting itself in nausea and vomiting. Examples of this morbid sympathy occur in carcinoma of the œsophagus, as well as in ulceration and in ordinary stricture of that tube. I have seen a foreign body, as a common cent, lodged in the œsophagus of a child, keep up nausea and vomiting until it was extracted. The irritation of the stomach, produced by tickling the fauces, is well known to every one. On the other hand, the œsophagus is liable to suffer very seriously from disease of other parts of the body. Thus, spasmodic stricture of this tube, sometimes of an exceedingly severe and intractable character, may be produced by disorder of the stomach, bowels, uterus, or spinal cord, which can only be relieved by addressing our remedies to the seat of the primary affection.

Disorder of the *bowels* is a prolific source of irritation, exhibiting itself in different viscera and tissues; for there are few organs whose sympathetic relations are of a more varied and extensive character. Allusion has already been made to the effects occasioned by the presence of worms in the alimentary canal; the retention of irritating matter often produces similar impressions upon the great nervous centres, followed in many cases, especially in infants and delicate nervous persons, by violent convulsions, disease of the arachnoid membrane, and palpitation of the heart. Itching of the nose, and various affections of the lips, tongue, and fauces, are frequently directly chargeable to dyspepsia, constipation, and other gastro-enteric derangement. What is called sick headache affords a familiar illustration of cerebral irritation dependent upon disorder of the stomach and bowels, or of these organs and of the liver. Costiveness never fails, when long continued, to oppress the brain, and to produce a sense of general malaise. Excessive itching of the pudendum and perineum is sometimes caused by the existence of worms in the alimentary canal.

There is an intimate sympathetic connection between the bladder and the rectum; also between the urethra and the lower bowel. In dysentery, hemorrhoids and fissure of the anus, strangury and spasmodic retention of urine are by no means uncommon, and are sometimes productive of great suffering. The ligation of a pile not unfrequently compels the surgeon to use the catheter for drawing off the urine; and I have known the vesical irritation in such a case to continue for several days. The same affections often cause spasmodic stricture of the urethra.

A very lively sympathy exists between the *teeth* and some of the other parts of the body; more intimate and extensive than would at first sight seem possible. Children, from the pressure of the teeth upon the gums, are extremely liable, especially during our hot summer months, to vomiting, diarrhœa, fever, and convulsions. Arachnitis occasionally supervenes upon difficult dentition; and certain affections of the skin, as eczema and porrigo, are frequently directly traceable to its effects, and rendered obstinate, if not temporarily incurable, by its persistence. A heated and tumid state of the gums, with thirst and redness of the skin, should be promptly met by the free division of these structures; otherwise, what is originally a mere irritation of the brain, stomach, or bowels, may soon be transformed into a fatal inflammation.

A decayed tooth, even when it does not itself ache, often causes severe pain in the face, temple, neck, throat, or ear; generally, but not by no means always, on the corresponding side, doubtless because all these parts are supplied by nerves derived from the same sources. When the ear is involved, the pain is propagated along the nervous cord of the tympa-

num, a filament of the second branch of the fifth pair of cerebral nerves. A carious tooth occasionally creates violent pain in a sound one, though at a distance from it, the suffering ceasing the moment the offending tooth is extracted. I have known a severe attack of pleurodynia to be kept up by a diseased tooth; the patient was bled and purged, but relief came only with the removal of the affected stump. Enlargement of the lymphatic glands of the neck, ulcers of the chin and cheek, epilepsy, hysteria, dyspepsia, and various other affections, sometimes of a very obstinate and distressing character, may be produced by carious teeth. It is difficult to conceive how a diseased tooth could keep up an attack of rheumatism of the hip, and yet the possibility of such an occurrence is established by some well-authenticated cases. Dysmenorrhœa has been cured by the extraction of several of the large grinders; and attacks of intermittent fever have been relieved in a similar manner, after the protracted but fruitless employment of bark and other remedies. A decayed tooth has been known to produce neuralgia of the arm, which promptly vanished upon its removal. Amaurosis, temporary and permanent, has occasionally been caused by diseased teeth in the upper jaw. In a case related by Hancock, a boy eleven years old was rapidly cured of total blindness by the extraction of two permanent bicuspids and four milk molars. Fricard met with a case of severe and obstinate tonsillitis, which yielded only after the free division of the indurated and swollen gum over the wisdom tooth.

The sympathetic relations of the *liver* are at once numerous and diversified, and any disturbance in them is generally productive of irritation in a number of the more important organs, especially the stomach, bowels, brain, heart, and lungs. The skin also frequently suffers in consequence of hepatic derangement, and, conversely, the liver from disorder of the cutaneous surface. Various medicines, as well as different kinds of food, are capable of seriously disturbing the functions of this organ; and it is well known that its secretions are often materially disordered by the direct influence of anxiety or strong mental emotion. An attack of jaundice is sometimes instantaneously produced by severe fright. The timid duellist and the affrighted soldier often suffer from this kind of irritation. Hepatic abscesses not unfrequently follow upon injury of the skull or brain; and, on the other hand, disease of the liver occasionally provokes serious cerebral irritation. Dyspnœa, palpitation of the heart, nausea, flatulence, and vomiting, are common effects of disease of this viscus. Pain in the top of the right shoulder has long been recognized by physicians as a symptom of hepatitis. Violent shock is occasionally followed by total suppression of bile; and the passage of a gallstone always causes intense gastric irritation.

5. *Urinary Organs.*—The *kidneys* have important sympathetic relations with different parts of the body, manifesting themselves in various forms of irritation. Thus, a renal calculus excites pain in the urethra, and a desire to urinate, and as it descends along the ureter, it occasions retraction of the testicles, and excessive irritability of the stomach. Severe injuries, involving great shock of the system, are often followed by total suppression of urine; and, on the other hand, there are various affections in which this fluid is poured out in enormous quantity.

The *bladder* also is variously affected by disturbance of its sympathetic relations. After injuries, as compound fractures and severe operations, the organ is often incapable of contracting upon its contents, thus necessitating the employment of the catheter; its perceptive faculties are suspended, and a few days usually elapse before they are reinstated, so as to enable the patient to pass his water without assistance. Stone in the bladder causes pain and burning in the head of the penis, and retraction of the testicle. Sometimes the pain is felt in the knee, heel, and foot; and a curious case has been reported where it was seated in the arm. For a long time the professional attendants were unable to discover the cause of the suffering; but at length, the man complaining of vesical trouble, a sound was introduced, when he was found to have stone, the removal of which put at once a stop to the unpleasant symptom. A very common effect of stone in the bladder is spasm of the sphincter muscle of the anus, which is often so great as to interfere with the passage of the finger. The introduction of a bougie into the urethra occasionally induces swooning, followed by violent rigors and high fever; and cases occur, although they are not common, of severe pain being excited in the extremity of the coccyx by such an operation. In the female, a papillary tumor at the orifice of the urethra will occasionally cause intense pain in the region of the bladder and kidney, with a frequent desire to urinate, and excessive scalding in passing water; in short, a train of phenomena closely resembling that produced by vesical calculus. A tight and elongated prepuce has been known to produce amblyopia and incontinence of urine.

6. *Genital Organs.*—There is perhaps no class of sympathies of greater interest, in a pathological and practical point of view, than those which subsist between the uterus and the general system. It was a knowledge of this circumstance which induced Aristotle to say that the womb was an animal within an animal. The morning sickness of early pregnancy, the hysterical convulsions, the depraved appetite, the rigors which usher in labor, and the contraction of the uterus when the cold hand is suddenly applied to the abdomen, are all examples of the mysterious relations by which this organ is bound to the rest of the body. Nowhere do these effects display themselves more strikingly than between the uterus and the mammary gland. During pregnancy, the breasts begin to sympathize at an early period, as is evinced by their tender and tumid condition ; and the effect which the application of the child to these organs has, soon after delivery, in causing after-pains, is familiar to every one. A knowledge of this fact has induced obstetric practitioners to take advantage of this means as a remedy for inducing contraction of the uterus in case of tardy expulsion of the placenta, or tendency to hemorrhage of this organ. The derangement of the stomach which accompanies prolapse of the uterus, the pain and swelling of the mammary gland from menstrual irritation, and the suppression of the lacteal secretion in puerperal fever, may be cited as additional illustrations of the intimate connection between the womb and the rest of the system. Excessive and intractable pruritus of the pudendum is occasionally produced by congestion of the uterus. Endometritis and congestion, ulceration, and a granular condition of the neck of the womb, especially in young females, occasionally give rise to severe pain in the hip and knee, to great distress in the head, to tenderness of the spine, to palpitation of the heart, to suffocative feelings, and to a host of other anomalous symptoms, generally promptly relieved by the removal of the exciting cause. Stone in the bladder has been known to simulate ulceration and carcinoma of this organ, causing a most embarrassing train of morbid phenomena.

An intimate sympathy exists between the testicle and the parotid gland. In mumps, or inflammation of the latter organ, it is by no means uncommon for the testicle, after the lapse of some days, to take on inflammation also, and generally to such an extent as to bear nearly the whole brunt of the disease. The translation of the morbid action is usually quite sudden, and the suffering of the testicle is often much greater than that of the parotid, being not only attended with severe pain and swelling, but occasionally terminating in complete atrophy of the seminiferous tubes. In what manner, or in accordance with what law of the animal economy, this occurrence takes place, it is impossible to determine, as there is no similarity of texture between these parts, or any direct nervous connection. The parotid is supplied with filaments from the ascending cervical nerves, and with branches from the fifth cranial ; the testicle, with filaments from the spermatic plexus, formed by the sympathetic.

7. *Skin.*—Remarkable sympathies exist between the skin and the mucous membrane of the alimentary canal, as well as between the cutaneous tissues and other parts of the body. Irritations, the result of a disturbance of these relationships, are of frequent occurrence, and serve to explain many morbid phenomena which, but for our knowledge of this circumstance, would be a complete mystery to us. The sympathy between the skin and mucous membrane is particularly close and intimate, arising from their great similarity of structure, it being well known that these tissues are convertible the one into the other, although there is no direct connection between them, except at the various mucous outlets ; here, however, it is inseparable, and this is perhaps one reason, if not the principal, why disease of the one is apt to cause disorder of the other. The fact that various substances taken into the stomach as food and medicine often produce the most singular cutaneous affections, within a short time after their introduction, is of daily occurrence. Every one's experience informs him of certain articles which he cannot use with impunity. There is no doubt that many diseases of the skin, generally of a very simple character, are often greatly aggravated and rendered obstinate, by inattention to the diet and neglect of the bowels and secretions ; and it will be readily conceded that the practitioner who is aware of this possesses a great advantage in the cure of these maladies over one who is ignorant of the circumstance, or wilfully disregards it. It is generally supposed that the skin suffers more frequently from disorder of the mucous membranes than the latter do from derangement of the former ; but this is probably a mistake. It must not be forgotten that there is a marked difference in respect to the relative frequency of the affections of these two classes of structures in different climates, and at different seasons of the year. In tropical regions the prejudicial effects of a disordered state of the skin show themselves

in a great variety of ways in the mucous membranes, especially those of the stomach and bowels, as in different forms of gastric irritation, diarrhœa, and dysentery. Erysipelas, carbuncle, and furuncle are generally supposed, and very correctly, to be essentially connected with disease of the chylopoietic viscera; indeed the more common varieties of these affections usually owe their origin to derangement of the stomach and bowels, and hence the practitioner rarely makes much progress towards a cure if he loses sight of this pathological relation. An unhealthy state of the skin often produces serious disease of the eye, brain, lungs, and liver, which is promptly relieved by attention to the cutaneous surface. Observation has shown that in bad cases of burns and scalds life is not unfrequently destroyed by ulceration of the duodenum, or the upper portion of the bowel, and yet it would puzzle the most profound physiologist to account for such an occurrence by a reference to any of the known laws of health and disease.

8. *Eyes.*—The eyes, like all symmetrical organs, have an important sympathy, not only with each other, but also with many other portions of the body, which displays itself both in health and disease, and not unfrequently becomes a cause of irritation and inflammation. A familiar example of this internuncial action occurs in cataract. When one eye suffers from this disease, the other, at no distant period, is very apt to become affected also. Even in ordinary ophthalmia a similar liability to the extension of the morbid action is exceedingly common. The sound eye either soon takes on inflammation, or, if it be so fortunate as to escape this disease, it is sure to become the seat of such an amount of morbid sensibility as to render it temporarily unfit for useful vision. A percussion cap, or other foreign body, lodged in one eye, has not unfrequently been the cause of destructive inflammation in the other; and this disposition to the involvement of both organs, where one is originally exclusively affected, is nowhere more forcibly and painfully exhibited than in amaurosis. It is true, it is not always easy, under these circumstances, to determine, in any given case, what share of the disease in the eye secondarily affected is due to the influence of consentaneous irritation, or to the operation of the same morbific agency which provoked the original malady; but it may reasonably be assumed, in the absence of positive information, that much, in the majority of instances, is the direct result of deranged sympathy. This liability of the eyes to participate in each other's diseases seems to be due to the intimate connection which exists between the optic nerves; and the same circumstance serves to explain the reason why the eyes are so frequently affected in organic disorders of the brain.

The eyes and nose are intimately related with each other, first, through the disturbance of the ophthalmic branch of the fifth pair of nerves, and, secondly, through the pituitary membrane, which is prolonged upwards through the lachrymal passages to form the conjunctiva. Hence it is easy to see how catarrhal affections should induce pain and redness in this membrane as it is reflected over the eyes; how snuff should excite a flow of tears; and how sudden exposure of the eyes to a strong light should cause sneezing. The connections which the frontal, infraorbital, and other nerves form with the filaments of the ophthalmic ganglion enable us to explain the occurrence of amaurosis in consequence of blows, wounds, and neuralgia of the face, eyebrows, forehead, and temples.

The eyes are connected with the abdominal viscera, particularly the stomach and bowels, through the medium of the branches of the sixth pair with the great sympathetic. The partial blindness consequent upon gastro-enteric irritation is readily accounted for in this way; and the same circumstance serves to explain the dilated state of the pupil which occasionally attends the presence of worms in the alimentary canal of children. It is probable that the pneumogastric nerves also play an important part in these sympathetic relations, otherwise it would be difficult to assign a reason for the excessive nausea and vomiting which now and then supervene upon injuries and operations of the eye, as severe blows and the depression of the cataract.

The eyes and teeth sometimes actively sympathize with each other, caries of the latter occasionally keeping up violent inflammation of the former, which promptly disappears upon the removal of the offending organ. I have several times seen the photophobia attendant upon strumous ophthalmia speedily yield in this way, after the failure of numerous other remedies.

9. *Ears.*—A curious sympathy, noticed by all aural practitioners, exists between the ears and the respiratory apparatus, and also between the ears and the stomach. Thus, pruritus of the auditory tube sometimes provokes coughing and vomiting; and the former of these effects, it is well known, is not unfrequently caused simply by probing or spong-

ing this passage in the removal of wax, or the extraction of a foreign body.   Sir William Wilde, in referring to this phenomenon, says that it is by no means unusual, although it cannot be produced in all cases. " I never witnessed it," he continues, "in children or very young persons; it is most common in males of about middle life, and is in no wise connected with any previous disease existing in the respiratory apparatus.   In some persons the slightest touch of the floor of the external auditory passage, about midway between its external outlet and the inferior attachment of the membrana tympani, will bring on violent irritation and spasmodic action in the larynx.   In this case also the patient will generally tell us, upon inquiry, that he does not experience pain; but the moment we touch this very sensitive spot he feels a tickling sensation in his throat, which immediately increases to the feeling one has when "a bit is gone astray."   What the nervous connection is which induces this has not been fully determined, but the fact is worthy of note."

Arnold has reported a case of chronic vomiting in a child, which long resisted a great variety of remedies, but was promptly cured by the extraction of a bean from each ear, the foreign substances having been introduced during play.   Mr. Toynbee had a patient who suffered under a cough which no treatment could subdue, but which promptly and permanently disappeared upon the removal of a fragment of dead bone from the auditory canal.   Numerous instances have been recorded of vertigo, reeling, and vomiting, caused by diseases of the ear.   Generally, those affections are chronic, and are often erroneously imputed to disorder of the stomach, liver, and bowels.

10. *Age and Effects.*—All persons are liable to suffer from irritation; but there is, as might be supposed, great diversity in this respect, in different individuals.   Thus, it is well known that persons of a nervous, irritable temperament are more prone to it than the sanguine and leucophlegmatic, owing no doubt to the fact that they possess a more delicate nervous system.   Women suffer more frequently than men, both from local and general irritation; and some of the worst forms of reflex irritation that the practitioner meets with occur in hysterical females.   Infants and children are extremely liable to the disease, the slightest cause often serving to light up the most distressing suffering.   Loss of sleep, anxiety, grief, hard study, intemperance, inordinate sexual indulgence, impoverished diet, and the enervating effects of a hot climate, all powerfully predispose to the occurrence of irritation.   The inhalation of impure air is another well-known cause operating injuriously upon the system.   A student who spends his nights in the foul atmosphere of the dissecting-room will be much more likely to suffer severely from the prick of his finger than one who enters it only occasionally.   In the one case the constitution is deteriorated by exposure, and therefore incapable of resisting the effects of disease; in the other it is healthy, and indisposed to take on morbid action.

An irritable state of the system often sadly interferes with the reparative process. Thus, the healing of a wound is sometimes suddenly arrested by an unhealthy state of the system, manifesting itself in a general exaltation of the nervous sensibility, altogether incompatible with the development of healthy blastema.   An aneurism of the aorta, attended with constitutional irritability, has been known to prevent the consolidation of a fracture of the femur.   These, and other similar facts, are of deep practical interest, as they are suggestive of valuable therapeutic measures.

Another very common effect of irritation, especially when extensive or seated in an important organ, is derangement of the secretions, not only of the parts more immediately affected, but of the rest of the system.   Thus, irritation of the brain, however induced, is very certain to disorder the functions of the stomach, liver, and kidneys, as evinced by indigestion, a bilious appearance of the skin, and a high-colored and scanty state of the urine.   The salivary glands, too, suffer, the mouth becoming dry and viscid; the head aches, the pulse is excited, and the extremities are cold.

Idiosyncrasy, a subject closely connected with irritation and sympathy, literally signifies a peculiarity of constitution, or a state of the general system in which certain articles, whether taken as food, drink, or medicine, produce an effect altogether different from what they do under ordinary circumstances.   Thus, lobster and other varieties of shellfish, although they may be used with perfect impunity by most persons, are extremely prone in some individuals to induce urticaria, vomiting, and purging.   A young lady, a patient of mine, married, robust, and of a florid complexion, cannot eat eggs, no matter how prepared, without being almost immediately seized with vomiting.   A gentleman of my acquaintance is always copiously purged after eating soft-boiled eggs; hard-

boiled eggs always agree with him. Milk acts on him in a manner similar to that of soft-boiled eggs. One of my grandchildren cannot eat strawberries without being instantly seized with some pain in the stomach. Some persons are overpowered by a particular odor or by the sight of blood. I know a lady who has not been able, for many years, to eat watermelon without being very speedily attacked with hoarseness, and soreness of the throat and mouth, attended with a burning, pricking sensation, nausea, and colicky pains. The use of watermelon-seed tea invariably produces a similar effect. Another lady, formerly a patient of mine, can never take an ordinary dose of laudanum without being copiously purged; opium affects her in a similar manner, but morphia does not. Laudanum, administered by the rectum, vomits freely and nauseates for many hours. These articles, however, always afford relief to her suffering. A lady patient of mine always experiences severe gastric pain after taking a dose of morphia or laudanum, or, in fact, opium in any form. In several persons of my acquaintance, among others a physician, the inhalation or odor of ipecacuanha invariably excites a violent attack of asthma, generally lasting for two or three days. In the case of the medical practitioner, the perception of the presence of this substance is so keen that, if he be in the third story of a house on the first floor of which an ordinary dose of the article is compounded, he is instantly seized with spasmodic cough and wheezing. A gentleman, for many years my patient, cannot drink a cup of green tea without being promptly and copiously purged; it usually operates on the bowels in from fifteen to twenty minutes after it is taken, bringing away thin, watery evacuations, accompanied with more or less griping; black tea produces no such effect, which he has experienced from the green from his earliest recollection. In two other cases, the use of green tea, even in very small quantity, invariably acts as a powerful diuretic, causing an abundant secretion of urine, with a frequent desire to void it for a number of hours. I lately prescribed for a middle-aged man, who is always copiously purged when he takes a glass of milk-punch, the action generally commencing in about one hour from the time he swallows it. Dr. Prout knew a man who could not eat mutton; no matter how it was disguised, he always promptly detected it, and it invariably caused violent vomiting and purging.

A patient of mine, an habitual asthmatic, thirty-five years of age, a tradesman by occupation, cannot enter a room where feathers are, without instantly experiencing an aggravation of his pulmonary affection. To provoke this effect, it is not necessary that he should see or smell the feathers; led blindfold into an apartment thus furnished, he is at once conscious of their presence, and is immediately compelled to retreat.

Idiosyncrasy not unfrequently displays itself in the operation of various medicines, affording thus useful hints to the practitioner in the selection of his remedies. There are many persons who cannot take opium in any form without being kept awake by it for hours and even days, besides suffering greatly from nausea, excessive itching, delirium and other distressing symptoms. The most minute quantity of mercury will, in some persons, cause profuse ptyalism, while in others the article may be given in large doses and for a long time without the slightest effect of this kind, the system being absolutely proof against the action of the medicine in any of its forms and modes of exhibition. Most individuals are freely purged by a drop of croton oil, and yet an instance is occasionally met with, in which hardly any operation upon the bowels is produced by twenty times that quantity.

The above instances, which might be multiplied to an almost indefinite extent from my own experience, will serve to illustrate a class of the most singular affections, the influence of which in modifying, if not in inducing disease, is eminently worthy of the attention of the practitioner.

TREATMENT.—In the treatment of irritation there are several leading indications which claim special attention. The first is to remove the exciting cause; the second, to correct the secretions; and the third, to palliate the disease, both primary and consecutive.

To remove the exciting cause of irritation is not always an easy task. In many cases, indeed, it is either wholly inappreciable, or can only be conjectured. The duty of the surgeon of course plainly is to get rid of it if he can; the ball, the calculus, the splinter of wood, the dead piece of bone, and the carious tooth, are promptly extracted. Irritating ingesta are dislodged by emetics; offending feces by purgatives; worms by anthelmintics. The mortified toe is amputated; the compressed gum lanced; the suppurating felon freely laid open. Light is excluded from the inflamed eye; noise from the suffering ear; cold from the shivering surface. In all such cases the indication is evident, and in general easily fulfilled. But it is otherwise when the cause is occult. Here the disease must be

met on general principles; and the judicious practitioner will do well to look into the condition of his patient's secretions, his bowels, and his diet, which are among the most common sources of the disease.

The correction of the secretions is a matter of primary importance in every case of irritation, whether local or constitutional. The manner of doing this will necessarily depend upon the character of the suffering organ; but no practitioner will fully discharge his duty, if he neglect attention to this point. The viscera whose derangements are most liable to provoke reflex irritation, are the stomach, bowels, liver, and uterus, and they should, therefore, always be objects of special consideration. Not unfrequently the cause of the trouble will be found to exist in irritation of the spine, or of some particular portion of the brain, demanding local depletion and counter-irritation, with perfect tranquillity of mind and body. Whatever the cause of the disturbance may be, it will be found that purgatives can rarely be dispensed with, while in not a few cases they constitute the chief anchor of our hopes. The diet, as a general rule, should be mild and unirritant, the proportions of its nutritive principles varying with the exigencies of each particular case.

The last indication is to cure the disease, or to palliate it if it be irremediable. To point out the methods of doing this in a class of affections of so protean a character as this, would be absurd. Every case must necessarily suggest its own treatment. In ordinary instances antiphlogistics, properly so called, may usually be dispensed with, and large draughts made upon the narcotic class of remedial agents, as their direct influence is to allay pain and spasm, and induce tranquillity of the system. The choice of the particular articles must be regulated by the circumstances of the case, and will often require no little judgment and experience for its successful exercise.

CHAPTER II.

CONGESTION.

It is practically a matter of no little importance that the surgeon should be able to discriminate accurately between inflammation and congestion; or, in other and more comprehensive terms, that he should possess clear and definite ideas respecting the more essential differences between these two morbid states; for upon their correct appreciation must often depend the result of his treatment. The subject, it must be confessed, is one of no ordinary difficulty, and a careful examination of what has been written upon it will serve to convince any unprejudiced mind that there are no two points in pathology concerning which there still prevails a greater amount of confusion; for what one author considers as congestion, another with equal confidence calls inflammation, and conversely; leaving thus the young and inexperienced practitioner in painful doubt not only in respect to the nature of the disease, but, what is far worse, in regard to its proper management. As the subject of inflammation will be fully discussed in the ensuing chapter, I shall limit myself here to a plain and simple exposition of some of the more important facts relative to congestion, preceded by an attempt to assign to this expression its legitimate import.

Congestion signifies an accumulation of blood in a part, the result either of some mechanical obstruction, or of disordered innervation, interfering with the onward movement of the sanguineous fluid. The word is synonymous with hyperemia, which Andral has proposed, without any just reason, as a substitute for it. It simply denotes the existence of an abnormal quantity of blood in a part, without any of the ordinary phenomena and effects of inflammation, which, however, it generally accompanies, if indeed it does not form a necessary consequence of the increased quantity of blood sent into the suffering structures in that disease. Pathologists usually divide congestion into two varieties, denominated, respectively, the active and the passive. The first, as the name implies, is characterized by inordinate activity of the part, as is evinced by its scarlet complexion, its augmented temperature, and its functional disturbance; and soon leads, if allowed to progress, to various kinds of deposits, particularly the serous and plastic. Passive congestion, on the other hand, is distinguished by the dark color of the part, the enlarged

and sluggish condition of the vessels, and the chronic march of the disease. Owing to these differences in the action and aspect of the affected structures, these two varieties of congestion are often denominated arterial and venous; terms which are ill chosen, as they have a tendency to create erroneous impressions respecting the true nature of the two lesions, for it is impossible to conceive of any case of congestion, however slight or severe, in which the disease is exclusively confined to one set of vessels.

It will thus be perceived that active congestion is closely allied to inflammation, although it does not, properly speaking, constitute inflammation, except in the opinion of certain pathologists, who, it seems to me, are not very felicitous in their attempts at separating the two affections from each other, although it is evident that they strive very hard to do so. They treat of congestion as a distinct entity, and yet they do not hesitate to ascribe to it phenomena and effects which belong exclusively to inflammation, and which congestion, considered in the proper sense of that term, is utterly incapable of producing. Whenever a part, however situated in relation to the amount of blood it contains, is the seat of morbid deposits, it has passed the stage of congestion, and gone over into that of inflammation. If this be not so, then it necessarily follows that active congestion and inflammation are essentially one and the same disease, and that, consequently, it would be absurd to attempt to describe them separately.

In all acute inflammations, whatever their cause or situation, active congestion is a necessary antecedent of the morbid action; one of the first links in the chain of the malady. Hence it would not be improper to say that it is a part of the inflammatory process, ushering in the disease, and continuing up to the very point of effusion; or, in other words, ceasing only where effusion commences. But this is strictly true only to a certain extent; for there is in every case of inflammation a circle beyond the process of the morbid action, where the blood, playing about in eddies, has accumulated in large quantity, distending the bloodvessels, and destined soon to part with some of its constituents, if the disease be merged in the inflammation. A veritable fire is lighted up here; the part is hot, abnormally red, and perhaps somewhat painful; nay, it may be, even a little tumid, from the dilated state of the vessels; the blood moves with unwonted force and velocity; the functional disturbance augments more and more; and presently congestion ceasing, inflammation takes its place, and goes through its allotted course. Another sign of distinction is that, in active congestion, the bloodvessels, although greatly crowded with blood, are more easily emptied than in inflammation: during life by pressure, and after death by injecting matter.

But active congestion is not always necessarily followed by inflammation, although prone to pass into that state if it continue even for a short time. The cause which induced it having been removed, the vessels cease to attract blood in undue quantity, and ridding themselves of what is redundant, speedily regain their normal caliber and function. A familiar illustration of this occurrence is afforded by the conjunctiva, when, from any transient cause, a sudden and violent rush of blood takes place to the affected part; in an instant hundreds of vessels, previously invisible, become apparent, being crowded with red blood, so as to give the surface almost a scarlet hue. Now, if we analyze these phenomena, it will be found that they depend simply upon a dilated state of the vessels of the eye and the presence of an unusual quantity of blood, containing a large number of red globules, which, in the healthy state, are either withheld from these vessels, or which are propelled along them in such small numbers as not to permit their coloring matter to become visible through their delicate walls.

Another familiar example of active congestion is furnished by what occurs in the hand when plunged into cold water, or exposed to a very low temperature. The skin soon becomes remarkably red from an unnatural afflux of blood, the parts are the seat of an unpleasant tingling sensation, and the vessels are exceedingly dilated; still, there is no inflammation, or any tendency to morbid deposit; the suffering structures are only irritated and preternaturally injected. Cautiously treated, the hand soon regains its natural condition, the skin recovers its former hue and sensibility, the blood ceases to accumulate, and the vessels resume their normal caliber. But it is otherwise when the case is unskilfully managed; the congestion then not only continues, but steadily increases, and is soon merged in inflammation, or perverted action and effusion.

Now, what occurs in the external parts of the body, immediately under the eye of the observer, may be supposed to happen, under similar circumstances, in the internal viscera. Thus, we know that when there is a sudden repulsion of the cutaneous perspiration, the blood is extremely apt to collect in the lungs, causing active congestion of the pulmonary tissues, so often the precursor of pneumonia. Poison introduced into the stomach almost

instantly induces active congestion of the mucous membrane of that organ, frequently followed, in a few hours, by the most intense and destructive inflammation. A ligature bound tightly round a limb affords a good illustration of the manner in which active congestion may be supposed to be induced in strangulation of the bowel in hernia and in intussusception.

A distinction should be made between active congestion in a part, and a determination of blood to a part. The former is always the effect of some morbific influence; the latter, on the contrary, may be the result simply of a natural cause. Thus, when the infant is applied to the breast, there is an instantaneous determination of blood to the organ, so as to enable the vessels to furnish the necessary supply of milk; during menstruation, there is a marked afflux of blood to the uterus, probably accompanied by more or less active congestion. In blushing, there is a rush of blood to the cheek; in erection, to the penis; in anger, joy, and other emotions, to the brain. Excessive, sudden, and overwhelming determination of blood to the internal organs sometimes takes place during the cold stage of intermittent fever, especially in that variety of it to which Alibert and others have applied the term malignant. In the congestive fever, as it is termed, of the Southern States, death not unfrequently results within a few hours after the commencement of the attack, the system never reacting from the effects of the chill. Scarlet fever occasionally proves fatal in a similar manner; the surface is pale or slightly livid, the extremities are deadly cold, and the internal organs are literally inundated with blood, determination and congestion coexisting in their worst forms.

In passive congestion, the morbid action is distinguished by its peculiarly sluggish character; the vessels are not only dilated, but frequently varicose, tortuous, elongated, and incapable of contracting upon their crowding contents; the discoloration is dark, venous, or purple, the circulation is tardy and languid, and there is often marked evidence of morbid deposits, especially of serum and lymph, in the cells of the areolar tissue.

Various causes may give rise to passive congestion. The most common are the following; 1st, inflammation; 2dly, mechanical obstruction; 3dly, debility; and 4thly, dependent position.

1st. Inflammation, in whatever form occurring, is almost always followed by a certain degree of passive congestion; the affected parts, exhausted by severe suffering, are reduced in strength and life-power; the vessels, dilated to their utmost capacity, and perhaps partially ruptured, are too feeble to contract upon their contents; the crippled structures are unusually vascular; and the slightest cause is generally sufficient to rekindle the disease. Indeed, as will be stated by and by, an organ that has been once severely inflamed is ever after extremely liable to become inflamed again; passive congestion often lasting for months and even years.

2dly. Mechanical obstruction is a prolific source of passive congestion. Examples occur almost without number, both in medical and surgical practice. I shall allude only to a few, as they will be sufficient for my purpose.

A good illustration of the effects of mechanical obstruction in producing passive congestion is seen in organic disease of the valves of the aorta, impeding the passage of the blood through the lungs. Compelled to remain here habitually in undue quantity, the pulmonary vessels soon fall into a state of passive congestion, which thus acts as a predisposing cause not only of inflammation, to which individuals so affected are extremely prone, but also of pulmonary apoplexy. Obstruction of the larger veins, as the femoral and iliac, is always followed by passive congestion in the parts below. In varicose enlargement of the veins of the leg, attended with disease of their valves, the blood has great difficulty in finding its way to the heart, and the consequence is that the distal portion of the limb is always in a state of passive congestion, with a strong tendency to inflammation, and to different deposits, more especially the serous and plastic. Obstruction of the artery of the leg, by fibrinous concretions, is always followed by congestion and inflammation, if not by gangrene of the foot.

The structures in the neighborhood of morbid growths are generally habitually congested; hence the profuse hemorrhage which so often attends their extirpation. Their vessels being compressed by the overlapping tumor, the passage of their contents is seriously interfered with, and hence they frequently undergo a remarkable dilatation, almost amounting to a real varicosity.

3dly. Debility of a part, however induced, is a frequent source of passive congestion. Examples of this form of the affection are seen in the retina and choroid coat of the eye from over-exertion of that organ, and in various parts of the body from loss of innervation, profuse hemorrhage, or other discharges, and from the natural wear and tear of the frame. If, under these circumstances, any particular organ is more feeble or exhausted

than the rest, it can scarcely fail to become the seat of passive congestion, or congestion and inflammation.

4thly. Dependent position readily gives rise to passive congestion. It is in this way that inflammation of the lungs is so often induced during the progress of lingering diseases and accidents, as typhoid fever, erysipelas, and compound fractures; the disease usually beginning in the posterior portions of these organs, in passive congestion, and proceeding gradually but steadily from bad to worse, until it proves fatal, a result so much the more to be dreaded on account of its insidious character. In the so-called bedsores, consequent upon long confinement in one posture, during which the pressure of the body is concentrated with peculiar force upon the sacrum, the iliac crest, and the great trochanter, similar effects are produced. There is, both in these and similar instances, in the first place a determination of blood to the most dependent portions of the body, then passive congestion, and finally, as a natural consequence, inflammation; often followed, in the latter case, by mortification.

Passive congestion, however induced, is a frequent cause of inflammation; often of a very destructive character, the more so, because the symptoms which attend it are so indistinct, if not so completely disguised, as to prevent the early recognition of their real import. It is for these reasons that the practitioner should constantly be on the alert whenever he has anything to do with diseases and injuries involving long confinement to one particular posture, and an unusual amount of expenditure of the vital forces.

Inasmuch as congestion may be induced by such a variety of causes, it would be folly to attempt to lay down anything like a regular systematic plan of treatment; to do so, would be to encroach upon every department of pathology and practice, both medical and surgical, of which we have any knowledge. The judicious surgeon, knowing how likely the continuance of such a condition is to be followed by inflammation, or to aggravate inflammation when these two states coexist, will do all in his power to avert the evil, or to combat it when he finds it has already taken place. The leading indication of cure, in every case of congestion, is to equalize the circulation; but to fulfil this often demands great judgment and an amount of pathological and therapeutic knowledge such as comparatively few practitioners possess.

CHAPTER III.

INFLAMMATION.

SECT. I.—GENERAL CONSIDERATIONS.

A THOROUGH knowledge of inflammation is indispensable to every practitioner of surgery. It should form the principal subject of his studies during his pupilage, and the main object of his professional contemplation in after-life. When it is recollected that there is hardly any disease which comes within the province of this department of science that does not originate in inflammation, or that is not more or less affected by it during its progress, the truth and force of these remarks will be sufficiently obvious. The smallest pimple upon the nose is, in point of fact, as much an inflammation as an erysipelas that covers the face and head. An ulcer of one of the mucous follicles of the mouth does not differ, in principle, from an ulcer of one of the glands of Peyer, which are the seat of so much disease and danger in typhoid fever. Many of the maladies, vaguely called nervous, are nothing but forms of inflammation, the nature and seat of which it is often difficult, if not impossible, to determine. Their predominant symptoms are of a nervous character, and hence the diseases which they accompany are usually considered as nervous, while in reality the reverse is too frequently the case.

All accidents, of whatever nature or degree, are, if not immediately fatal, necessarily followed by inflammation. The little wound made in cupping, and the bite inflicted in leeching, would never heal without the aid of this process; the parts would remain open, and be the seat of incessant bleeding, or they would become festering and putrid sores. In a word, there would be no repair after any injury, however simple; and operative surgery, instead of being a blessing, would be a positive evil. Thus, it will be perceived, that inflammation is capable of playing, as it were, a double game in the animal economy,

being at one time a cause of death, and at another a source of life. It is for this reason that it is often designated by the terms healthy and unhealthy, according as the one or the other of these states predominates.

Inflammation may be defined to be a perverted action of the capillary vessels and of the perivascular tissues, attended with discoloration, pain, heat, swelling, and disordered function, with a tendency to effusion, deposits, or new products. In addition to these changes, there is also an altered condition of the blood and nervous fluid as an important element of the morbid process. In what inflammation essentially consists, it is as impossible to determine as it is to explain the intimate character of attraction, repulsion, gravitation, or cohesion. Hence, the medical philosopher, in studying its history, is necessarily obliged to limit himself to an examination of its causes, symptoms, and effects, or, in other words, to a rigid analysis of its appreciable phenomena and consequences.

1. CAUSES OF INFLAMMATION.

The causes of inflammation are almost as numerous as the circumstances which surround us, and are either predisposing or exciting. Whatever has a tendency to affect injuriously the mental or physical organization, whether directly or indirectly, is capable either of inducing disease, or of laying its foundation. The predisposing causes are those which produce in the system, or in some particular part of it, certain changes, states, or conditions favorable to the development of inflammation, without actually provoking it. They are usually tardy in their operation, and are either natural or acquired, according as they are inherent in the constitution or dependent upon accidental circumstances. The exciting causes, on the contrary, are those that are directly concerned in awakening the disease, or fanning it, as it were, into existence. It is not always, however, in our power to ascertain either the predisposing or exciting causes of the morbid action, and hence such cases, which are by no means uncommon, are usually known as occult cases.

The natural *predisposing causes* of disease have reference to peculiarities of constitution, and to a tainted state of the economy, in consequence of hereditary transmission. To the former class belong plethora, debility, and nervous susceptibility, which prepare the system for disease, by the changes which they induce in the fluids and solids. Persons who have naturally an undue quantity of blood, as indicated by their ruddy complexion, and the extraordinary functional activity of their organs, are peculiarly prone to inflammation ; their bodies may be compared to a mass of tinder, which the slightest spark is capable of kindling into a devouring flame. Those, on the other hand, who are naturally feeble, are remarkably prone to local congestions, which, especially when they become habitual, are sure to lead to inflammation, often of a very unmanageable character, because it cannot be met by the ordinary remedies. Persons of a nervous temperament are predisposed to maladies of the brain, spinal cord, and sympathetic nerves, as exhibited in derangement of the respiratory, digestive, and genito-urinary apparatus ; maladies which are generally tardy in their progress, and often so obscurely marked as to be difficult of recognition.

The fact that some diseases are transmissible from the parent to the offspring is well known. There are family diseases, as there are family likenesses, manners, and peculiarities ; and, what is remarkable, they are more liable to be communicated by the mother than the father, as if it were her special prerogative to impress her vices, as well as her virtues, upon her descendants. Another law is that some of these diseases may skip one generation to reappear in another, and that it is not necessary that the parents should be actually laboring under an attack of them at the period of conception. The affections which may be transmitted in this way are gout and rheumatism, phthisis, asthma, scrofula, carcinoma, and constitutional syphilis, together with some others which it is unnecessary here to specify. It is in this wise, apparently, that God visits the sins of the parents to the third and fourth generations of their offspring. In what element of the economy the germ of the morbid action is locked up, neither reason nor experience has been able to determine ; for a time it would seem to be latent in the blood, when it explodes, either suddenly, or gradually, with zymotic violence.

Among the acquired predisposing causes of inflammation are, the effects of previous disease, plethora, and debility, however induced. An organ that has once labored under inflammation is extremely prone to suffer from it again from the most trivial causes. The part, enfeebled by the attack, does not recover completely from its effects for a long time,

if ever. Hence, influences which, in the natural state, would not disturb its physiological relations, are, under such circumstances, peculiarly prone to excite disease. A familiar illustration of this fact is afforded in the tonsillitis of children, in whom a recurrence of the malady is generally awakened by the slightest exposure to cold. Organic disease of one organ predisposes to organic disease in another, especially if in intimate sympathy with it. Albuminuria is a powerful predisposing cause of erysipelas, pyemia, furuncle, and carbuncle. It is not necessary here to enlarge upon plethora and debility as predisposing causes of inflammation. If these states of the system are capable of preparing it for the development of disease when they are a natural result of the organization, it may readily be supposed that they would be much more likely to produce such an effect when they are acquired, in consequence of the mode of life of the individual, or of the influence of structural lesion.

Age, sex, temperament, occupation, food, dress, exercise, climate, and season, are all so many predisposing causes of inflammation. Infancy is particularly obnoxious to enteritis, croup, diphtheria, and arachnitis; childhood, to affections of the skin, struma, parotitis, and tonsillitis; manhood, to pneumonitis, carditis, and diseases of the genito-urinary organs; and the decline of life, to gout and rheumatism, asthma, arteritis, and the various forms of malignant maladies.

The differences in regard to the susceptibility to inflammation in the two sexes arise mainly from their anatomical peculiarities, and are much less common than is generally imagined. The function of parturition renders the female particularly liable to peritonitis, phlebitis, arachnitis, and carcinoma; while the male, from his occupation and mode of life, is more prone to cystitis, urethritis, gout, rheumatism, arteritis, hepatitis, pneumonitis, and pleuritis.

Of the influence of temperament, as a predisposing cause of disease, too little is known to enable us to speak with any degree of certainty. The sanguine temperament, characterized by plethora with inordinate capillary activity, disposes to inflammation of the internal organs; the nervous, to inflammation of the nervous system; the lymphatic, to inflammation of the skin, joints, serous membranes, stomach, bowels, and lymphatic glands.

Occupation is a powerful predisposing cause of inflammation. Persons who work a great deal in the open air, and who are much exposed to cold and wet, are extremely liable to suffer from pneumonia, arthritis, tonsillitis, and enteritis. A sedentary life leads to chronic disorder of the alimentary canal; and, if conjoined with constant mental exertion, is liable to be followed by disease of the brain and arachnoid membrane. Excessive exercise of an organ, as of the larynx in singing and speaking, is a predisposing cause of inflammation.

The influence of food in disposing to inflammation is well known. The habitual use of stimulating articles of diet, especially when conjoined with want of exercise in the open air, is among the most powerful of the causes under notice. On the other hand, an impoverished diet, or a privation of nitrogenous food, by inducing a defective blood, leads to scurvy, chlorosis, typhoid fever, scrofula, and inflammation of the serous structures, terminating in dropsical effusions. Certain articles, as ergot, if employed for any length of time, or in any considerable quantity, dispose to arteritis and gangrene of the extremities. The habitual indulgence in alcoholic drinks leads to gastro-enteritis, hepatitis, and attacks of epidemic diseases, whenever such diseases are prevalent.

Dress may be an indirect cause of inflammation. It may keep the body too warm or too cold, or exert injurious compression; in either event, local congestion will be apt to be induced, which the slightest circumstances may fan into disease.

A change of climate, whether from hot to cold, or cold to hot, powerfully predisposes to inflammation. Hence the period of acclimation is always peculiarly trying, and few persons escape without suffering. Season, too, exerts a predisposing influence. Thus, in summer, inflammation is most prone to assail the stomach and bowels; in winter, the larynx, lungs, pleura, joints, and throat.

Mental excitement is a prolific source of inflammation. Fear, grief, anxiety, hard study, and loss of sleep, by deranging the secretions, and interfering with the digestive process, all dispose to this disease. In short, whatever interrupts, disorders, or arrests healthy action, exerts a pernicious influence. This is often the only way in which we can account for the occurrence of erysipelas, carbuncle, rheumatism, cerebritis, scrofula, and carcinoma.

The *exciting causes* of inflammation are extremely numerous, and of the most diversified nature; they act in two ways, either directly upon a part, or indirectly through the sys-

tem. Hence they are said to be local and constitutional ; and the former are either of a chemical or mechanical character.

Among the chemical causes are, first, high degree of heat, as hot water and iron ; secondly, partial application of cold ; thirdly, caustic substances, as the alkalies and acids ; fourthly, acrid vapors, hartshorn, and gases ; fifthly, certain secretions, as urine and bile ; sixthly, blisters, embrocations, and rubefacients ; and lastly, various septic agents, as those of smallpox, syphilis, glanders, and malignant pustule. All these agents act directly upon the parts to which they are applied, either destroying them by their immediate effects, or combining with them in such a manner as to change completely their structure and function. Their operation is always rapid, and the resulting inflammation is usually marked by severe symptoms, both local and constitutional.

The mechanical causes comprise, first, punctures, incisions, contusions, and lacerations ; secondly, fractures and dislocations ; thirdly, sudden and forcible distensions, as from the accumulation of pus, serum, blood, or gas ; fourthly, compression, as by bandage, ligature, posture, or effused fluids ; and fifthly, the presence of foreign bodies, as a stone in the bladder, a bean in the air-passages, a bullet in the flesh, a tubercle in the lung, or a fibrinous concretion in the brain. Thrombosis, or the formation of clots in the blood-vessels, leading to obstruction in the circulation, frequently occasions inflammation. The manner in which these various causes act in producing disease is too evident to require explanation.

The constitutional causes of inflammation make their impression either directly upon the part, or indirectly through some remote structure. Logically speaking, it would perhaps be more proper to say that they all act in the latter way, and not in any case immediately upon the part, as it is usually asserted they do. Thus, a morbific impression primarily made upon the respiratory passages, as the inhalation of some noxious gas, or the contact of malaria, instead of causing disease in the lungs, or in some of its constituents, often, if not generally, explodes upon some other organ, perhaps very distantly, if at all associated with the lungs by sympathy, or similarity of structure and function. A septic poison, as, for example, the virus of smallpox, introduced into the system, acts not merely upon the blood into which it has been conveyed by the absorbent vessels, but also, and mainly, upon the cutaneous tissues, for which it evidently has a greater elective affinity than for any other part of the economy ; if it produces any action at all upon other structures, it is altogether of an indirect character. In the transmission of secondary syphilis from the parent to the offspring, the force of the disease is spent, in the first instance, upon the skin and the mucous membrane of the throat and mouth ; there is no inflammation, so far as we are able to determine, in the connective, fibrous, and serous tissues, or in the internal organs, properly so called. In tertiary syphilis the bones, periosteum, and cartilages are particularly prone to suffer, although the disorder has a more general tendency, as there is more profound contamination of the system.

Whatever doubt, however, there may still be respecting the mode of action of the above agents, there can be none about the operation of heat and cold, which are such prolific causes of inflammation. The influence of a tropical sun, acting upon an impressible nervous system, in producing hepatitis, is well known to the practitioners of our Southern States, and to those of Africa, Asia, and the West Indies. Gastritis and enteritis, in their worst forms, are often developed in a similar manner. The occurrence of tonsillitis, croup, pleurisy, pneumonia, enteritis, cystitis, and rheumatism, as an effect of cold feet, is familiar to every one. In all these instances the primary impression is made through the medium of the skin, by suppressing the perspiration, and throwing the onus of the functional disorder upon some internal and remote organ, between which and the cutaneous surface there is not the least direct connection.

Excessive shock, whether induced by direct nervous exhaustion, or by loss of blood, is a prolific cause of inflammation, often followed by the worst consequences. The inflammation which succeeds to gunshot, railway, and other severe injuries, is generally extremely violent, and is prone, if the patient survive their more immediate effects, to give rise to secondary lesions, often more fatal than the primary. The system thus affected does not seem to have sufficient vitality to keep the morbid action within proper limits : hence its disposition to spread not only over the parts originally implicated, but to other structures, more or less remotely situated.

A part, deprived of nervous fluid, readily falls into inflammation, as is shown in injuries of the forearm involving the division of the radial and ulnar nerves, in which the thumb and fingers, and sometimes even the entire hand, always suffer more or less severely from this cause. Steady and long-continued compression of a nerve, interfering with the

transmission of nerve fluid, may lead to similar results, as is witnessed, for example, in bedsores.

Inadequate supply of food is a common cause of inflammation. Animals starved for experimental purposes are liable to suffer from inflammation and ulceration of the mucous membrane of the intestines; and similar effects have often been observed in persons in health deprived of their accustomed supply of aliment. Scurvy and other affections are produced by a deficiency of alkaline and neutral salts in the blood, especially the salts of potassium. Hence the value of the liberal use of lemon-juice in protracted voyages in the Arctic regions.

The blood itself is a frequent source of inflammation; sometimes, because it is overloaded with earthy salts or other irritating materials, as the poison of erysipelas, carbuncle, pyæmia, and various eruptive diseases; at other times, because of its impoverished condition, rendering it unfit as a supporter of life. There is reason to believe that the latter cause lies at the foundation of many of those low and unhealthy forms of inflammation which so often eventuate in destructive ulceration of the mucous and cutaneous tissues, as well as of some of the worst forms of morbid deposits, as imperfectly vitalized lymph, albumen, and tubercle. Deficient secretion, especially of the liver, kidneys, and skin, is a frequent cause of disease, various substances being thus retained in the circulation, much to the detriment of the general economy, as well as of particular organs, perhaps already predisposed to morbid action. The non-elimination of the products of tissue-metamorphoses is a prolific source of congestion and inflammation.

From the foregoing considerations it will be perceived that inflammation may be *traumatic* or *idiopathic*, that is, produced by external injury or by constitutional causes, the latter of which are often wholly inappreciable by our senses.

Inflammation is sometimes caused by *sympathy*. Thus, the eye occasionally suffers from disorder of the stomach, the brain from derangement of the intestines, the mamma from disease of the uterus, the testicle from lesion of the urethra. A person who habitually overtaxes his digestive powers, and takes withal hardly any exercise, will be very liable, eventually, to perish from carbuncle or erysipelas; or, at all events, to have disease, in some form or other, of the skin, simply because these parts are intimately related to each other by similarity of structure and function. For the same reason disease of the skin is very prone to be followed by disorder of the alimentary canal.

Finally, inflammation may be caused by *metastasis*, an event, which, as the term implies, is characterized by a transfer, for the most part gradual, but occasionally very sudden, of irritation from the part originally affected to another, perhaps at a considerable distance from it, and in no wise related to it by structure or function. In inflammation of the parotid gland the testis is often involved in this way, but why it is, neither our anatomical nor physiological knowledge enables us to explain, as there is no traceable connection whatever between them. In rheumatism of the joints the heart often suffers; and in erysipelas of the skin the morbid action frequently leaves one part of the surface and breaks out upon another. Such occurrences, which are sometimes greatly promoted by our local applications, should always be sedulously watched, as they are generally fraught with danger, especially when they show themselves in important internal structures.

2. EXTENSION OF INFLAMMATION.

All inflammations, of whatever character or grade, are, in the first instance, strictly local, beginning in some particular tissue, spot, or point, from which, as from a common focus, the morbid action radiates in different directions, until it becomes, so to speak, general. Thus, to illustrate, let it be supposed that the malady commences at a certain part of the mucous coat of the small bowel, as, for example, in one of the glands of Peyer. After having remained here for a short time, it gradually spreads to the fibro-cellular lamella, then to the muscular fibres, and finally to the peritoneal investment, involving thereby the whole in one mass of disease. In erysipelas the same law is observed. Here the morbid action, beginning at a little point of skin, gradually extends to the deeper structures, until, as in the case of a limb, it invades connective tissue, aponeurosis, muscle, vessels, nerves, periosteum, and occasionally even bone. A pneumonia, in its progress, usually involves the pulmonary pleura and the bronchial mucous membrane.

The rapidity with which inflammation extends from one texture to another is extremely variable; in some instances the time is very short, perhaps not exceeding a few hours or even a few minutes, as, for instance, in cases of snake-poisoning; and such cases are, it may be remarked, generally very prone to be characterized by more than usual

violence. It must not, however, be inferred from this statement that the morbid action always spreads from the point originally attacked; for, although there is unquestionably a very strong tendency to this, yet there are numerous exceptions to it. In some cases this limitation is due to the nature of the disease itself; in others it depends upon the deposit of plastic matter; while in a third series of cases it is owing to the structure of the overlying tissue, as, for example, in the periosteum, which often serves to protect the bone which it surrounds from the encroachment of disease of the soft parts.

One of the most common modes in which inflammation propagates itself is by *continuity of structure*. The morbid action, once begun, easily passes along the tissues in which it originated, often spreading rapidly over a large extent of surface, similarity of structure and function favoring its march. By continuity of surface an erysipelas of the skin, perhaps not larger at its commencement than half a dime, frequently in a few hours diffuses itself over an entire limb, or even the greater portion of the body. In the same manner inflammation is liable to be propagated along the mucous canals, as is exemplified in the tonsillitis, croup, and other affections of the throat and air-passages, and in the various diseases of the stomach, bowels, and genito-urinary apparatus. In duodenitis the morbid action may readily extend along the choledoch and hepatic ducts to the liver; and in gonorrhœa nothing is more common than for the disease to spread along the seminal passages to the epididymis and testis.

Secondly, inflammation may be propagated by *contiguity of structure*. A phlegmonous erysipelas of the skin has a tendency not merely to spread over the neighboring surface, in consequence of its similarity of structure and function, but also in depth, thereby involving connective tissue, aponeurosis, muscle, and, in short, every other texture within its reach. The tissues mainly concerned in the enterprise are the vascular and connective, the peculiar structure of which renders them highly favorable for the propagation of the morbid action. An inflammation, beginning in the conjunctiva, often in its progress involves the entire eye, simply from the intimate manner in which its different tunics are superimposed upon each other. In the bowel and other mucous canals the same effect is frequently witnessed. In pneumonia, especially in the more violent forms, the disease is rarely confined to the parenchymatous substance, but is almost sure eventually to spread to the pleura and bronchia. In orchitis, although the inflammation is primarily seated in the tubular structure of the epididymis and testicle, it is by no means uncommon for it to extend to the albugineous and even to the vaginal coat. An inflammation of the synovial membrane of a joint often spreads, by virtue of the same law, to the articular cartilage and the head of the bone beneath, contiguity and intimate connection favoring here, as elsewhere, the propagation of morbid action.

Thirdly, the extension may be effected through the agency of the *veins* and *lymphatics*. Of the former a good example is afforded by what occasionally happens in venesection, where, apparently from the use of a foul lancet, the inflammation sometimes spreads from the little wound in the vessel, at the bend of the arm, as high up as the right auricle of the heart; and of the latter by what occurs in chancroid, where the poison, taken up by the absorbent vessels of the penis, is conveyed by them to the glands of the groin, where it causes a painful swelling, constituting what is termed a bubo. In dissection wounds the absorbent vessels always serve as vehicles for the transmission of the peculiar poison which gives to these lesions their characteristic features. For a short period after the inoculation the poison is apparently latent, when its effects show themselves by one or more red lines extending up the limb as far as the axillary glands, whence, as from a common centre, its injurious impressions are radiated over the whole system.

Of the extension of inflammation by *nervous agency*, or sympathy, a familiar example is afforded in parotitis. In this disease, which attacks chiefly young subjects, the inflammation often suddenly leaves the organ originally involved, and fastens itself upon the testicle, which is thus compelled to bear the whole onus of the morbid action. Of the precise manner in which this transfer is effected nothing is known. As there is no direct nervous connection between these structures, the only plausible conjecture is, that it is brought about by the operation of sympathy, although of the nature of this operation it is impossible, in the present state of the science, to form any correct idea. A similar relationship exists between the mamma and the uterus, the stomach and the lungs, and between the stomach and the brain, or, rather, between the former organ and the arachnoid membrane.

Finally, inflammation may be propagated by the *blood*. This fluid, as will be more fully explained by and by, undergoes various changes in this disease, of which the most important is an increase of fibrin and colorless globules, with a strong tendency of these

substances to adhere to the sides of the vessels as they are propelled along with the general circulating mass. The blood, thus altered in its properties, leads to obstruction of the capillaries in different parts of the body, thereby establishing foci of morbid action. It is in this manner that metastatic abscess, or what is now known as pyemia, is occasionally produced, as is proved by the fact that the aggregation of the colorless corpuscles into small masses, and their adhesion to the walls of the vessels, not only diminish the rapidity of the circulation, but favor the formation of thrombi and the production of embolism.

3. VARIETIES OF INFLAMMATION.

With the exception, perhaps, of the epidermis, the hairs, and the nails, there is no part of the body which is not susceptible of inflammation and its consequences. The reason why these structures are usually considered incapable of this process is our inability to demonstrate in them any bloodvessels, nerves, and lymphatics, the great and essential elements of organization in the more elaborate and complex tissues. Notwithstanding this, it is extremely difficult to unite in so sweeping a conclusion, when we reflect upon the fact, of which daily observation furnishes examples, that these external coverings undergo various lesions of forms, size, color, and consistence, which can only be explained on the assumption that they are the products of inflammation, modified by the nature of the affected parts. There are other structures, as the arachnoid membrane, the cornea, and some of the cartilages, in which it is impossible to detect vessels, and yet no one would doubt for a moment, on this account, that they are incapable of disease. No exception should, therefore, in my opinion, be made, as it respects the possibility of the occurrence of inflammation, even in regard to the cuticle, the hair, and nails.

The susceptibility of a part to inflammation is, as a rule, in direct proportion to the amount of its vascular and nervous endowments, the importance of its functions, and the nature of its exposure. Hence it is found to be most common in the skin, connective tissue, mucous and serous membranes, joints, lungs, liver, kidneys, bladder, urethra, ovaries, and uterus. The only exceptions to this law are the brain and heart, which notwithstanding their incessant labor, the excessive delicacy of their organization, and their universal sympathetic relations, are comparatively rarely the subjects of inflammation. In the thyroid body, the salivary glands, the pancreas, the prostate, and the spleen, the voluntary muscles and their tendons, the nerves, vessels, fibrous membranes, and even the bones, the disease is also uncommon, although several of these structures are sufficiently prone to inflammation as it manifests itself in certain forms of syphilis, scrofula, and rheumatism. It is easy to see why the skin should be so frequently affected, when we reflect upon its vast extent, its wonderful vascularity and nervous endowments, its sympathy with the brain, lungs, stomach, and, in fact, almost every organ in the economy, and its constant exposure to all kinds of injurious impressions. For the same reason it is not difficult to account for the frequent occurrence of pneumonia, hepatitis, nephritis, and inflammation of some of the other viscera. The connective tissue, although less highly organized than the skin, is yet a frequent subject of disease, inasmuch as it is the great link by which the various textures are connected together, and the means of transmission of the vessels and nerves from one part to another. The functional activity alone of some of the organs affords a ready key to their liability to inflammation. Thus, the genital organs are almost exempt from disease until the age of puberty, when, their slumbering season being over, and their fretful life having begun, they are extremely prone to morbid action, both common and specific.

The progress of inflammation exhibits much diversity, being at one time rapid, at another slow; hence the distinction into *acute and chronic*. An acute attack is one which, running its course swiftly, is characterized by well-marked symptoms, as is seen, for example, in tonsillitis consequent upon a severe cold, where, in the space of a few days, the affected gland acquires a large bulk from vascular engorgement and interstitial deposits, attended with great local and constitutional disturbance. Force and rapidity of action are its distinguishing features. Chronic inflammation, on the contrary, is marked by comparative slowness and feebleness of action; the attendant phenomena are also less bold, although there is generally a decided tendency to effusion. It may be the sequel of an acute attack, or occur as a primitive affection, existing, perhaps, for a considerable period without being discovered, owing to the absence of the usual diagnostic signs. Once in this condition, it may last almost for an indefinite time, as is exemplified in certain cases of gleet, leucorrhœa, tonsillitis, osteitis, arthritis, otorrhœa, and ophthalmia.

In addition to the terms acute and chronic, so frequently employed in surgical nomenclature, there are certain expressions in use to designate the degree of the morbid action, as, for example, acute when the action is very intense, subacute when it is comparatively mild, and passive when it is very sluggish, or indisposed, as it were, either to advance or to recede, and accompanied, perhaps, by inordinate congestion of the vessels, especially of the veins, with little, if any, pain, and no marked constitutional disturbance.

Inflammation is said to be *healthy* or *unhealthy*, according as it manifests a tendency to restoration or to mischief. It would be erroneous to regard inflammation always in the light of a disease, since it is the means which nature must necessarily employ whenever she repairs an injury that has given rise to it. It is only when the process proceeds, as it were, blindly, that it is likely to be productive of harm by overpowering the part and system. An incised wound, in a sound constitution, will, if properly managed, heal promptly by union by the first intention; whereas, if the reverse be the case, its edges will be sure to separate, and, suppuration taking place, a long time may elapse before the object is fully attained. In the one case the action is said to be healthy, in the other unhealthy; and it will generally be found that the nature of the action is a true index of the condition of the part and system; as the latter is, so will be the former. There are of course exceptions to this law, but they are infrequent and unimportant.

There is a form of inflammation known as the *irritable*, but which in reality does not differ materially from unhealthy inflammation. The best illustrations of it occur in strumous ophthalmia, in ulcers of the extremities, in rupia, and in chronic tonsillitis, bronchitis, dysentery, cystitis, urethritis, and orchitis. It evidently depends upon an exaltation of the natural sensibility of the affected structures, aggravated by an unsound state of the nervous system.

Inflammation may be *common* or *specific*: common, when it proceeds from ordinary causes; specific, when it is produced by some peculiar poison, as that of gonorrhœa, syphilis, or smallpox. A more important distinction is that certain inflammations are capable of appearing only in certain tissues. Thus, erysipelas is generally a disease of the skin; in rare instances it involves the mucous membrane of the mouth and throat, and, perhaps, also the peritoneum and pelvic veins, as in lying-in females; but it never, so far as can be ascertained, fastens itself, as a primary affection, upon the muscles, aponeuroses, nerves, arteries, bones, cartilages, or internal viscera. Gout and rheumatism have a special fancy for the joints and fibro-serous textures; secondary syphilis, for the skin and fauces; tertiary syphilis, for the bones and periosteum; scrofula, for the lymphatic glands; and carcinoma, for the glandular organs, as the mamma, uterus, and liver. Finally, there are certain diseases, as smallpox, syphilis, and scarlatina, which occur, as a rule, only once in the same person.

Finally, inflammation may be *latent*, or fail to reveal itself by the ordinary phenomena. Such an inflammation is always to be dreaded, because, owing to its insidious character, it is extremely liable to be overlooked. A striking illustration of this form of disease is afforded by the glands of Peyer in typhoid fever, the inflammation and ulceration of which constitute the anatomical lesions of that formidable malady. Patients thus affected seldom complain of pain, or, indeed, of any other suffering directly referable to these bodies, even when the morbid action is so extensive as to induce perforation of the bowel. Latent pneumonia is sufficiently common; and abscesses of the spine and other parts of the body often make great havoc before their true nature is even suspected.

4. TERMINATIONS, EVENTS, OR CONDITIONS OF INFLAMMATION.

Although inflammation is generally said to have various terminations, it will be found, upon strict inquiry, that these amount only to two, all the rest being so many states, conditions, or events of the process. This distinction is real, not imaginary, and therefore of no little practical value. Philosophically speaking, there are only two terminations of the morbid action, the one being in health, the other in the death of the parts. The former may occur by delitescence and resolution; the latter, by ulceration and gangrene. All deposits, whether serous, plastic, purulent, or sanguineous; and all changes of structure, whether they consist in softening, induration, contraction, or thickening, are to be viewed simply as so many products, effects, or results of inflammation, without necessarily involving a suspension of the process itself. This indeed may still go on, sometimes even for an indefinite period, and thus produce additional changes, more serious, perhaps, in their consequences than those which attend the act in its earliest stages. In suppuration, for example, the inflammation does not generally end the moment matter forms, or as

soon as the pyogenic crisis has been fairly attained; instead of this, it proceeds in a modified state, accompanied by ulceration, or still further deposits. The same remarks are applicable to the exudation of plasma, and even of serum, the latter of which may be regarded as one of the processes employed by nature to deplete the inflamed tissues; in this, however, she generally succeeds only by degrees, as is shown by the fact that the disease often continues for a considerable length of time after the drainage has commenced. Blood, either perfectly pure, or variously combined with the secretions of the affected surface, may be poured out quite freely, and yet the morbid action continue as vigorously as before, as is exemplified in dysentery and other hemorrhagic forms of inflammation. There is, therefore, really no such thing as a termination of inflammation in effusion of serum, deposit of plasma, or the formation of pus. These events occurring, the morbid action may still go on, merely modified by the influence exerted upon it by the attendant secretion or the nature of the morbid product.

The nomenclature of inflammation has been much simplified in modern times. As it now stands, it is based essentially upon the anatomy of the affected tissue, structure, or organ, the term itis being merely added to the name by which the part is generally known, as sclerotitis, cystitis, laryngitis. Sometimes, however, the old expressions are retained, as quinsy for inflammation of the tonsils, ophthalmia for inflammation of the eye, and gonorrhœa for inflammation of the urethra.

SECT. II.—ACUTE INFLAMMATION.

The symptoms of inflammation naturally divide themselves into local and constitutional; or those furnished by the part and those afforded by the general system.

1. LOCAL SYMPTOMS.

The most prominent external symptoms of inflammation have been known from an early period of the profession. They are tersely stated by Celsus as "rubor, calor cum tumore et dolore." The knowledge, however, of the Roman physician of inflammation was extremely imperfect, and it was not indeed until some time after the commencement of the present century that the subject began to be studied in its relations with the different organs and tissues of the body. Bordeu, Carmichael Smith, and Bichat, by laying the foundation of general anatomy, paved the way to a more comprehensive acquaintance with the nature and seat of morbid action, and were thus instrumental in revealing an amount of light, the beneficial effects of which can even yet be hardly foreseen. They show what might, a priori, have been anticipated, that the phenomena enumerated by Celsus, as characteristic of inflammation, are liable to great and constant variations, according to the nature of the affected structure, and that the most violent morbid action may often be present, and yet nearly all of these phenomena be absent. Hence, at the present day, too much stress cannot be laid upon disordered function, inasmuch as this is frequently the only symptom that is at all appreciable, especially in inflammation of the internal organs. Modern research has shed important light upon the condition of the capillary vessels and their contents, as well as upon the condition of the cells in inflammation, and has enabled us to explain many phenomena that were previously obscure and mysterious in regard to the more intimate nature of the process.

1. *Discoloration.*— The discoloration of an inflamed part varies from the slightest increase of the natural hue to the deepest purple, according to the character of the affected tissues and the intensity of the morbid action. It is always, other things being equal, most distinctly marked in those structures which are very vascular, while in such as have comparatively few vessels it is either entirely wanting, or present only in a faint degree. It is a prominent phenomenon in inflammation of the skin and mucous membranes, connective tissue, lungs, pleura, spleen, kidneys, and peritoneum; structures which are distinguished by their great vascularity, and by the large amount of blood admitted into them in disease. On the other hand, there is but little discoloration in inflammation, however intense, of the tendons, cartilages, bones, fibrous envelops, brain, nerves, heart, and voluntary muscles. In inflammation of the arachnoid membrane the only evidence of disease observable after death is effusion of serum or of serum and plasma; there is no trace of vascularity, and yet the morbid action has been sufficient to destroy life.

The rapidity with which the discoloration of inflammation advances is greatly influenced by the severity of the morbid action, and, above all, by the activity of the circulation of

the affected structures. In general, however, it proceeds rather slowly, keeping steady pace with the gravescent action ; advancing from rose to red, from red to purple, or from purple to black, as when the part is about to mortify. It is always most distinct at the focus of the inflammation, from which it gradually recedes until, in most cases, it is insensibly lost in the natural hue of the surrounding healthy structures. Occasionally, as in erysipelas of the skin, as well as in some affections of the mucous membranes, the line of demarcation is very abrupt, the diseased surface exhibiting a red and well-defined circle.

The discoloration varies not merely in degree, but also in character, thereby throwing, not unfrequently, important light upon the diagnosis of the case. Thus, it may be scarlet, as in the skin, throat, and bowels ; lilac or bluish, as in the sclerotica and the fibrous envelops of the muscles ; brick-colored, grayish, or brownish, as in iritis ; yellowish, as in erysipelas, especially when this disease is associated with derangement of the biliary secretion ; of a copper hue, as in the eruptions of secondary syphilis ; purple, as in the edges of a scrofulous ulcer ; livid, as in violent tonsillitis ; black, as in mortification. These varieties of color, in these and other structures, are dependent, partly upon the organization of the affected tissues, partly upon the nature of the inflammation itself, and partly upon the amount, degree, or intensity of the morbid action.

In extent the discoloration varies, from the smallest speck, perhaps not larger than a pin's head, to a surface occupying many inches, if not several feet in diameter, as in erysipelas, which sometimes involves the greater portion of the body. When this is the case, the discoloration is said to be diffuse ; it is arborescent, when the vessels upon which it depends are arranged in dendritic lines ; punctiform, when it occurs in little dots, or points, as in some of the inflammations of the serous and mucous membranes ; linear, when it presents itself in a distinct line, as in phlebitis and angeioleucitis ; maculiform, when it assumes the appearance of a blotch or of an ecchymosis. In the latter case, as well as in the punctiform variety of discoloration, the morbid hue is due to an actual extravasation of blood, consequent upon the rupture of some of the capillary vessels of the part.

To be of value as a diagnostic sign of inflammation, the discoloration must be permanent, not transient ; advancing and receding with the morbid action ; disappearing under pressure, but reappearing the moment the pressure is taken off. The blush of shame vanishes in an instant, with the excitement that produced it ; the hectic flush upon the cheek of the consumptive merely denotes the existence of the fever which succeeds the afternoon's rigor ; they are very different from the discoloration which marks the rise, progress, and termination of inflammation. Besides, the latter is usually associated with other symptoms, as heat, pain, swelling, and disordered function ; phenomena sufficiently distinctive, in every case, to prevent error of diagnosis. More or less discoloration generally remains, in a modified form, for some time after the inflammation has ceased.

The immediate cause of the changes of color in inflammation is a preternatural afflux of blood. In the normal condition of the organs and tissues there are hundreds and thousands of capillary vessels which are too minute to admit of a sufficiency of red globules to render them visible, but which, under the influence of irritation, become distended to such a degree as to display themselves in every direction. It is in this manner that the discoloration of the affected structures is brought about, often in an instant, as is witnessed, for example, in the conjunctiva, when a particle of foreign matter lodges upon the cornea ; and what occurs here unquestionably occurs, under similar circumstances, in other structures. It is only in reparative inflammation, or in inflammation concerned in rebuilding wasted tissues, that new vessels are formed ; never in ordinary inflammation.

2. *Pain.*—Pain, like discoloration, is one of the most constant symptoms of inflammation, usually setting in early in the disease, going on steadily increasing until the morbid action has attained its maximum, and then gradually abating, as the disease recedes, until it is insensibly lost. The subject of pain presents several points of interest, which, as they have a practical importance, should be well understood by the surgeon.

Pain varies in degree from the slightest change in the normal sensibility of the part to the most excruciating agony, according to the nature of the affected structure, and the intensity of the morbid action. Doubtless idiosyncrasy also exerts an important influence, for it is well known that what causes pain in one individual, causes little, if any, in another. Few persons suffer much from the application of a blister, but occasionally, although it may be retained only for a few hours, it is productive of the most exquisite torture. Such a result can only be explained by assuming that there is an idiosyncrasy, or a difference in the nervous organization of our patients. The same remark is true in regard to the effects of injury. As a rule, the pain is greatest at the focus of the inflammation, and

fixed in its situation, but sometimes it darts about in different directions; is increased by pressure, motion, and change of posture; and rarely intermits, although it often remits, especially in the morning and in the early part of the forenoon.

In regard to the character of the pain, there is great diversity, so much so, indeed, that it is often possible, from this circumstance alone, to form a tolerably correct idea of the seat, and even of the nature, of the inflammation. Thus, in the pleura it is sharp and lancinating; in the connective tissue, acute and throbbing, as is exemplified in boil and carbuncle; in the liver and lungs, obtuse and heavy; in the testis, sickening; in the skin, prurient, itching, or smarting; in the bones, dull and gnawing, as if insects were feeding upon the part; in the urethra, scalding or burning; in the conjunctiva, gritty and itching; in the teeth, throbbing, beating, or pulsatile. When inflammation is about to terminate in mortification, the pain generally becomes hot and burning.

Pain is sometimes felt at a point more or less remote from the seat of the morbid action, and for this reason does not always serve to denote its existence. In coxalgia, the earliest and most prominent symptom usually is severe pain in the knee, and it has often happened, especially in the hands of ignorant and inexperienced practitioners, that the latter has been leeched, cupped, and blistered, when all this care should have been bestowed upon the hip. In inflammation of the bladder, ureters, and kidneys, a prominent symptom is uneasiness in the head of the penis; and in hepatitis considerable suffering is occasionally felt in the right shoulder. In certain cases of carcinoma of the uterus, the pain, instead of being located in this organ, is situated in the mamma, the sides, the back, groins, or thighs. It is not always easy to explain these occurrences; but, in general, they are dependent either upon continuity of structure, as in the case of the urinary passages, or upon reflex action, as in coxalgia and hepatitis. In the latter, something may possibly be due to disorder of the intercosto-humeral nerves.

It is worthy of note that the pain is generally much more violent in inflammation of the covering of an organ than in inflammation of its proper substance. A pleuritis is always attended with severe local distress, whereas very little, if any, is experienced in pneumonitis. In inflammation of the parenchymatous structure of the liver, great disorganization may take place, and yet the patient be entirely ignorant of the fact, as far as pain is concerned; but when the fibro-serous envelop of the organ is mainly implicated, violent suffering is always a prominent symptom. The same law obtains even in inflammation of the brain and its membranes. Pain, especially in chronic inflammation, as gout and rheumatism, is greatly influenced by atmospheric vicissitudes, as is evinced by the fact that it is always more severe in damp than in dry weather. Nocturnal exacerbations are very common, if not constant, in inflammation of the bones and joints, particularly in syphilitic subjects.

A correct distinction should be drawn between the pain of inflammation and the pain of spasm, as it exercises an important influence upon the treatment of the case. The former, as previously stated, is gradual, not sudden, in its attack; persistent, not intermittent; increased by motion, pressure, and posture; and is, moreover, generally accompanied by more or less febrile disturbance, and other evidences of indisposition, plainly marking its character, to say nothing of the history of the case, which usually furnishes important light in regard to the diagnosis. In spasm, the pain comes on suddenly, and, after having continued for a short time, intermits, or entirely disappears, only, however, to return again, and to pass through the same course; in a word, it is paroxysmal, coming suddenly, and going suddenly; relieved by pressure, and nearly always attended with eructations, and rumbling noises in the bowels, supposing the case to be one of colic; there is no fever—indeed, generally no constitutional excitement of any kind—and there is also an absence of the other local symptoms of inflammation, as heat, discoloration, and swelling.

In neuralgia the pain is sharp and lancinating, often darting through the parts with the rapidity of lightning, or like an electric shock; accompanied by a sense of soreness or aching, and generally aggravated by pressure. It is usually paroxysmal, coming on perhaps once every day, lasting a few hours, and then going off gradually, or even suddenly, to reappear about the same time the following day; it is, in fact, generally an intermittent disease, with a distinct interval of freedom from pain, resembling, in this respect, an ordinary intermittent fever, and having often, like it, a miasmatic origin. The pain, moreover, is not always fixed, but is at one time here, and at another time there, generally in the course of a sentient nerve.

Severe pain, especially in a nervous, irritable person, is always a formidable occurrence, as it exhausts and depresses the powers of life, and is sure, if not speedily combated, to occasion serious, if not fatal, mischief. The rule, therefore, is to arrest it

promptly, and at all hazards, before the disease, of which it is a symptom, has committed any serious ravages.

A sudden disappearance of pain, unless occasioned by the use of anodynes, is generally denotive of danger, as it implies a termination of the morbid action in the death of the affected structures. The occurrence should, at all events, excite suspicion, and lead to careful investigation. An individual, for example, has been the subject of strangulated hernia; the constriction has lasted for several days, and has been characterized by severe suffering, both local and general; suddenly the pain ceases, and the patient flatters himself that he will soon be well. The surgeon, however, comes to a widely different conclusion; for the sunken features, the clammy skin, the feeble, flickering pulse, the incessant hiccough, and the trembling hand, but too plainly foreshadow the approach of death from mortification of the bowel.

Pain is not always present, even although the inflammation may be extremely violent. In typhoid fever, a disease attended with inflammation of the glands of Peyer, often terminating in extensive ulceration, there is generally an entire absence of this symptom, from first to last, unless the case is followed by perforation of the bowel, and an escape of its contents into the peritoneal cavity. In pneumonia there is frequently no pain whatever; and the same is true of inflammation of some of the other viscera. In scrofulous affections of the spine, particularly in those forms of it known as Pott's disease and psoas abscess, pain, properly so called, is one of the rarest phenomena, especially in the earlier stages of their progress. A painless inflammation is peculiarly dangerous, inasmuch as it is very liable to be overlooked by the professional attendant, particularly by one who is in the habit of placing undue confidence in the ordinary phenomena of the disease.

The immediate cause of pain is the compression experienced by the nerves at the seat of the morbid action by the dilated vessels, but more especially by the inflammatory deposits, thereby interrupting the transmission of their peculiar fluid, which thus accumulates and explodes at the point of obstruction, like the fluid in an electric battery. The nerves themselves necessarily participate in the disorder, sharing the same fate as the other tissues, and so increasing the suffering.

Of the intimate nature of pain nothing is known beyond the fact that it consists of a peculiar mental perception, dependent upon a healthy state of the brain. There must be consciousness, otherwise there cannot be any cognizance of the mischief wrought by disease. Of this a convincing proof is afforded in what occurs in apoplexy and paraplegia, in which the most violent inflammation may be set up, both in the internal and the external structures, and yet the patient be utterly insensible of its presence. The brain and nerves being crippled, the latter are unable to convey, and the former to receive, painful impressions.

Although pain is a great evil, it is extremely fortunate that it is so generally present in inflammation, inasmuch as it serves to warn the patient of his danger, and usually supplies the practitioner with important information respecting the nature and seat of the morbid action. How many persons formerly perished of typhoid fever simply because there was no pain to guide the physician to the true lesions of the disease!

What is termed *throbbing* is a peculiar form of pain, generally denotive of the approach of suppuration. It is, however, sometimes felt at an early stage of the morbid action, especially when it involves the fibrous, fibro-serous, and osseous tissues. It is generally dependent, in the first instance, upon an unusually crowded state of the capillary vessels, impeding the flow of blood, and afterwards, when the disease is more fully developed, also upon the presence of inflammatory deposits. Posture exerts a powerful influence upon its production, as is evinced in whitlow, odontalgia, and common furuncle. In the first of these affections the pain is increased a hundredfold, almost in an instant, when the hand is lowered; a decayed tooth that is free from pain in the day, while the patient is walking about, aches intensely the moment he lies down at night; and a boil on the buttock, which causes hardly any uneasiness during recumbency, throbs violently when the body is erect.

3. *Swelling.*—Swelling is seldom entirely absent in inflammation of the external parts of the body, but very generally in that of certain internal structures, however violent or extensive the morbid action. Under the latter head may be enumerated, in particular, the fibrous and serous membranes, tendons, cartilages, bones, vessels, and nerves, along with most of the different viscera. The mucous membranes also may suffer in this way; the principal points where swelling is liable to occur, as a result of inflammation, are the conjunctiva, glottis, tonsils, and vulva, for the reason that these parts are largely supplied

with lax cellular material, which, wherever it exists, readily admits of infiltration of serous and other fluids. Hence it is that swelling is generally so conspicuous in inflammation of the subcutaneous and intermuscular connective tissues, especially in the extremities, and sometimes even in the head, as is noticed in the more severe forms of erysipelas, where the scalp and face are occasionally puffed up to an enormous extent, frightfully disfiguring the features.

The progress of the swelling varies; in general it is gradual, beginning early in the inflammation, and increasing steadily until the morbid action has attained its height; even then, however, it does not always stop, but often continues until the vessels have parted with their more fluid contents, which sometimes occurs only after the disease has begun to decline. Occasionally, however, the swelling is most rapid and extensive, spreading, in a short time, over an entire limb, or even the greater portion of the body. The best examples of this occurrence are witnessed in certain injuries, as compound fractures and dislocations, phlegmonous erysipelas, and the inflammation consequent upon the application of steam, alkalies, acids, and certain animal poisons, as that of the rattlesnake.

The swelling varies in its character; thus it may be soft or hard, transient or protracted, beneficial or injurious. A soft swelling is usually denotive of serous effusion; a hard one, of a deposit of plasma, or of the more solid elements of the blood. A transient swelling is generally less prejudicial than a protracted one, as it is less likely to interfere with the restoration of function. Swelling often proves beneficial, inasmuch as the effusion upon which it depends is a means of depletion employed by nature to relieve inflammatory action; it answers, in fact, the same purpose as a blister or a topical bleeding. When, however, the deposit is very large, or composed essentially of solid material, it may produce immense harm by compressing the capillary vessels and thus interfering with the transmission of their contents; in other words, the effusion chokes the parts, and thereby causes fatal constriction. In swelling of the conjunctiva, technically called chemosis, the matter poured out often compresses the vessels of the cornea in such a manner as to induce gangrene of this membrane; and a like result not unfrequently follows phlegmonous erysipelas of the limbs and scrotum. Swelling may prove injurious in another way; by acting obstructingly, as in œdema of the glottis, which may cause death by preventing the ingress of air into the lungs. A similar effect may be produced by inordinate tumefaction of the tonsils. A swollen perineum may compress the urethra, and thus occasion retention of urine.

The immediate cause of swelling is twofold: first, engorgement of the capillary vessels, and secondly, and mainly, effusion of serum and plasma; to which, in the more severe forms of inflammation, may be added pus and blood, the latter of which is sometimes poured out in considerable quantity.

4. *Heat.*—An increase of heat is one of the most common effects of inflammation, and hence a valuable symptom of the disease. A good illustration of this occurrence is observed in tonsillitis, gastritis, pneumonia, and the so-called fevers, in which there is often a remarkable heat of the breath; and also in many of the external varieties of inflammation, where the change is rendered apparent both by the sense of touch and by the rapid evaporation of our applications. The scalding tear in inflammation of the eye is an evidence of the same fact.

The degree of heat, emitted in the act of inflammation, was at one time supposed never to exceed that of the blood in the heart and large vessels. The researches of John Hunter strikingly countenanced this opinion. In operating upon a man for the radical cure of hydrocele, the temperature of the vaginal tunic immediately after the withdrawal of the fluid was ascertained to be 92°. The cavity was now stuffed with lint, and the next day the thermometer stood at 98¾°, thus showing an increase of six degrees and three-quarters, which must have fully equalled the heat of the blood in the heart and large vessels of the patient. In repeating the experiment subsequently upon a muscular wound in the side of a dog, and upon the vagina of an ass, irritated by a solution of bichloride of mercury, he found no difference whatever, before or after the occurrence of inflammation in the temperature of the parts. Hence, he naturally concluded that the extrication of heat during the progress of this morbid process was either very slight or altogether inappreciable. Observations, however, made since the time of the English philosopher, conclusively show that there is frequently, if not generally, a decided increase of temperature in the inflamed structures; and, although this increase may not render the temperature of the part equal to that of the heat of the blood in the heart, yet it is none

the less real and positive. It is well known that the outskirts of the body, as the feet, hands, and ears, are habitually cooler than the trunk, head, and upper portions of the extremities, because they have naturally a more feeble circulation : hence, in inflammation, although their temperature may not reach 98° of Fahrenheit, yet if there be any elevation of heat over and above what these structures enjoy in the healthy state, it is to be considered as an actual augmentation. That this is the fact, in all the more severe forms of inflammation, personal observations, many times repeated, fully satisfy me. In erysipelas of the skin of the trunk, in urinous infiltration of the scrotum, in acute abscess, in tonsillitis, orchitis, bubo, and other affections, I have again and again seen the mercury arise above 100°, and in some instances even as high as 105°, 106°, and 107°. The oviduct of a frog ready to spawn is two degrees warmer than its heart ; and Professor Dunglison saw the temperature of the uterus during labor rise as high as 106°. From a consideration of facts such as these it is impossible to avoid the conclusion that there is generally an elevation of heat in inflammation, in whatever part of the body situated, provided the concomitant action is not too slight, or too limited in extent. A marked increase, followed by a decided decrease, of temperature, follows the section of certain nerves, notably of those belonging to the sympathetic system, in the structures supplied by the wounded cords.

The nature of animal heat is not sufficiently understood to justify us in expressing any decided opinion regarding the cause of its increase in inflammation. It may be supposed, however, to be mainly due, first, to the friction which the blood experiences in its passage through the vessels, not only in the inflamed parts, but in the system at large ; secondly, to the oxidation of the carbon and other material introduced into the system in our food ; and, thirdly, to the rapid union of the oxygen of the air with the red particles of this fluid as it is propelled along in its turbulent course. The influence of an accelerated state of the circulation upon the production of animal heat is well exemplified in what occurs in ordinary exercise when the feet are cold. A rapid walk under such circumstances in the open air soon equalizes the circulation, and sends the blood, loaded with oxygen, to every part of the body, warming it as it rushes on. If a horse be rode swiftly round the race-track, his whole body becomes intensely heated, and the blood surcharged with fibrin and colorless globules ; both evidently the result of the increased friction of the blood against the coats of the vessels, and the rapid union of the oxygen of the air with that fluid. Irritating applications, as spirits of ammonia, blisters, sinapisms, and embrocations, by inviting a preternatural afflux of blood to the affected part, produce an analogous effect, accelerating the circulation and causing an elevation of temperature. The augmented heat of the uterus during parturition can only be explained on the supposition of an increased activity of its vessels, approximating to a state similar to that which obtains in inflammation, although not identical with it. During the growth of the antler of the deer and of other animals there is always a marked elevation of temperature ; and phenomena of a similar kind are often witnessed during the development of malignant and other tumors. All these occurrences bear directly upon the question under consideration, if they do not positively serve to establish its truth.

5. *Tension.*—A sense of tension, pressure, weight, or fulness is a prominent symptom in inflammation, and often greatly aggravates the local and general distress. It is particularly conspicuous in inflammation of the denser structures, as the fibrous membranes, tendons, and cartilages, but it is also not unfrequently very severe in the more lax, as in the mucous membranes and the connective tissue. The immediate cause of the tension is the presence of effused fluids, as serum, lymph, and pus, which thus compress and constrict the affected parts. It is not improbable that mere congestion, or inordinate distension of the capillary vessels, may produce a similar effect. In either event, however, it is necessary that the parts should be more or less severely inflamed, and abnormally sensitive ; otherwise the feeling cannot arise, as is proved by the fact that mere distension, however considerable, will not induce it, as is exemplified in anasarca of the lower extremities, the penis, scrotum, and eyelids, where the accumulation is often enormous, and yet no sense of tension is experienced during any period of the attack.

Great tension sometimes occurs in inflammation of the viscera, as the liver, spleen, kidney, and prostate gland. When combined with throbbing, it is generally denotive of incipient suppuration. In orchitis, tension is usually a prominent symptom. It is seldom, if ever, absent in boils, carbuncles, erysipelas, and paronychia. Occasionally tension seems to be a purely nervous phenomenon, as, for example, in what is called sick-headache.

6. *Functional Disorder.*—Disorder of the functions of the affected part is generally a most important symptom, as it is often present when all, or nearly all, the other phenomena are absent. It manifests itself in various ways, as well as in various degrees; at one time in increased sensibility or irritability, at another as a suppression, alteration, or augmentation of the natural discharge, and now as an abolition of some special sense; at one time as the slightest possible departure from the normal action of the part, and at another as a total suspension of it.

An increase of *sensibility* is one of the most common effects of inflammation. In peritonitis, gastritis, and enteritis, the sensibility of the affected structures is often so great as to render the slightest pressure of the finger a source of profound distress; and it is for the same reason that, under such circumstances, the weight even of a sheet is sometimes almost intolerable. Similar effects are noticed in some of the external diseases, as in boil, carbuncle, erysipelas, and in inflamed hemorrhoidal tumors, which are frequently the seat of the most exquisite tenderness, hardly exceeded by that which attends an inflamed eye. Parts which are devoid of feeling, or nearly so, in the sound state, such as ligaments, tendons, bone, and fibrous membranes, generally become exceedingly sensitive in inflammation. The change in question is diagnostically of great importance, inasmuch as it usually enables us to distinguish readily between inflammatory and spasmodic affections, the latter of which, as before stated, are often immensely relieved by pressure, which never fails to aggravate the former.

An increase of *irritability* is a very constant phenomenon in all inflammations of muscular parts. In cystitis, one of the earliest and most prominent symptoms is a frequent desire to urinate, arising from involvement of the muscular fibres of the bladder; in gastritis, the irritability of the stomach is so excessive that the organ is incapable of retaining the smallest quantity of fluid, however bland; and in dysentery, the principal suffering is due to the incessant peristaltic action of the colon and rectum, the main seats of the morbid action. An increase of the contractility of the voluntary muscles is very common in fractures and dislocations, in severe sprains, and after amputation, usually manifesting itself in spasmodic twitchings, which can only be relieved by the liberal use of anodynes.

Inflammation produces important changes in the special functions of an organ, sometimes exalting, at other times diminishing or even completely suspending them. In ophthalmia, the eye cannot look at objects, however dim; the moment the effort is made, the lids contract spasmodically, and the smallest ray of light that impinges upon the retina is productive of the greatest distress. In inflammation of the ear, the slightest noise, which in the healthy state would perhaps not be perceived, or which might fall as delightful music upon the tympanum, becomes a source of deep distress; and the sense of hearing is almost destroyed by the buzzing and explosive sounds which succeed the morbid action. In coryza, the sense of smell is abolished; in inflammation of the skin, the sense of touch; in glossitis, the sense of taste. In laryngitis the voice is at first merely altered in its character, but as the disease progresses complete aphonia often ensues. In cerebritis there is generally delirium, followed, if the case passes on to suppuration, by convulsions and coma, the precursors of speedy dissolution.

Another prominent symptom of inflammation, one, indeed, which is seldom absent, is disorder of the *secretions.* Thus, in inflammation of the skin, there is suppression of the perspiration; in hepatitis, of the bile; in nephritis, of the urine. Or, instead of an arrest partial or complete, of these and other secretions, important changes are effected in their composition, or in their physical, chemical, and microscopical properties. In pneumonia, the characteristic symptom is a rust-colored sputum; in dysentery, a discharge of bloody mucus.

The function of *absorption* is often seriously impeded, if not completely checked, in inflammation. The disorder, however, is generally much more conspicuous in the advanced than in the early stages of inflammation, in which this process is sometimes executed, even with a certain degree of vigor, as is demonstrated by the facility with which morphia and other substances are carried into the system when placed upon the skin after vesication by cantharides, ammonia, or hot water. In the more violent grades of inflammation, the function is usually in a state of abeyance, the action of the absorbent vessels being arrested by the morbid deposits. Afterwards, however, as the disease declines, the function of absorption is gradually reëstablished, and then often proceeds with great vigor, rapidly removing the fluids effused during the earlier stages of the inflammation.

It is worthy of notice that while the absorbent vessels, during the height of inflammation, refuse to take up extraneous matter, as, for example, morphia or belladonna, and also

effused fluids, they are often very busy in removing affected textures, even when of a very firm and resisting character. A familiar illustration of this occurrence is afforded in acute abscesses, the natural evacuation of which is frequently accomplished by the agency of the absorbent vessels, where the disease is most intense. In inflammation of the joints, cartilage and even bone often suffer extensively from this cause. There is no doubt that the pressure of effused fluids always greatly influences and promotes the occurrence.

2. CONSTITUTIONAL SYMPTOMS.

Constitutional symptoms do not always attend inflammation. The morbid action may be so mild as to prevent its recognition by the system; it is strictly a local affection, and therefore causes no general resentment. But the case is very different when the disease is severe, or when, even if comparatively slight, it involves an important structure; then the whole frame feels its irritating and depressing effects, and evinces a strong interest in the impending struggle. The group of phenomena thus produced constitutes what is termed inflammatory, symptomatic, or sympathetic fever, and deserves consideration as expressive of the sum of suffering of each particular organ. The period which intervenes between the establishment of the inflammation and the occurrence of fever varies from a few hours to several days, depending upon the nature of the exciting cause, the condition of the patient, the intensity of the disease, and, above all, the importance of the organ attacked. Idiopathic inflammation is generally preceded by depression or a sense of lassitude and uneasiness, attended with headache, pain in the back and limbs, bad taste in the mouth, vitiated appetite, and slight chilliness, alternating with flushes of heat. Sometimes the patient is remarkably desponding, or annoyed with disagreeable dreams, and unpleasant forebodings respecting his recovery. He feels uncomfortably, both bodily and mentally, and is disinclined to exertion. In a word, he is unwell, or in a state intermediate between health and sickness. These phenomena, which are merely the precursors of the fever, which is as yet only in a state of incubation, may be compared, not inaptly, to the fleeting clouds which precede the outbreak of a storm; they appear and vanish for a time, but gradually coalescing, at length assume their allotted station in the chain of morbid changes. When fully established, the fever never intermits so long as the cause which has produced it continues in operation; it, however, generally remits slightly in the morning, and sometimes, although rarely, twice in the twenty-four hours. The vesperal exacerbation, during which the temperature rises to 102° or 103° Fahr., usually sets in late in the afternoon, and persists, with but little alteration, until towards morning, when the excitement relaxes its hold, as if in need of temporary repose to meet the gradually recurring emergency. During the calm which is now present, the patient often falls into a refreshing sleep, his thirst and restlessness subside, and the skin is bedewed with a gentle perspiration. Soon, however, the smothered fire is rekindled, and the same suffering has to be passed through as before, now, perhaps, augmented by the spread of the morbid action, and the development of new sympathies.

The type of the attendant fever varies. In young and robust subjects, and in the earlier stages of the disease, it is generally of a sthenic character, and asthenic under opposite circumstances. Very frequently the symptoms are denotive of great debility from the very commencement of the attack. In some cases both the sthenic and asthenic types are associated with excessive irritability, constituting what is called the nervous form of inflammatory fever.

The nature of inflammatory fever can only be fully comprehended by thoroughly interrogating, as it were, every organ of the body supposed to evince any sympathy with the affected structures. Such an inquiry must, of course, embrace an examination of the heart and arteries, the countenance, skin and extremities, lungs, tongue, stomach, bowels, liver, kidneys, and bladder, together with the state of the muscles, brain, and assimilative powers.

Derangement of the *vascular system* is chiefly denoted by the state of the pulse, the principal characteristics of which are frequency, hardness, fulness, strength, and quickness. The number of beats in a minute ranges from seventy, seventy-three, or seventy-five, the average standard in the healthy adult, to eighty-five, ninety-five, one hundred, or even one hundred and twenty, according to the intensity of the disease and the vigor of the constitution. A hard pulse is firm and resisting, rolling under the finger like a tense cord, as if the blood were sent into it with extreme power; sometimes the artery thrills or vibrates, owing to a partial displacement synchronous with the contraction of the left ventricle of the heart. When the tension is unusually great, it is difficult, even

with forcible pressure, to obliterate the caliber of the vessels. Fulness has reference to the volume of the pulse, which feels as if the artery were expanded beyond its normal size. Strength implies a sensation of preternatural resistance to the finger; while a quick pulse is one in which each beat occurs with great suddenness or abruptness. This quality of the pulse is generally associated with frequency, from which, however, it differs essentially, as the latter has reference merely to the number of strokes in a given time, and not to the rapidity with which the vessel dilates and contracts under the finger. Several of these states of the pulse may be absent, and yet the case be one of great disorder of the vascular system. Their entire coexistence, in fact, is uncommon; perhaps the nearest approach to it is to be found in gout and rheumatism, hepatitis, pleurisy, splenitis, and the commencement of smallpox.

The pulse is often materially modified by the nature and seat of the inflammation and by the idiosyncrasy of the patient. In cephalic affections, it is slow, full, and laboring, in consonance with the oppressed condition of the heart; in peritonitis, it is small, frequent, and wiry, sometimes, in fact, almost undistinguishable; and in acute inflammation attended with internal venous congestion, as in certain forms of fever and injury, it is obscure and apparently feeble, but generally rises under the effects of remedies, or the powers of the system. Idiosyncrasy often singularly modifies the state of the pulse. A middle-aged man, a patient of mine, has a pulse habitually under forty, and other examples of this abnormal condition, equally striking, have fallen under my observation. On the other hand, it may be unnaturally frequent, beating constantly from eighty to ninety in the minute.

Peculiarities like those here instanced, whether the result of disease or of idiosyncrasy, derive a special value from the influence which they must necessarily exert upon our diagnosis and treatment. Thus, in peritonitis, the practitioner, if governed solely by the state of the pulse, without any knowledge of the condition of the system which causes it, would be almost sure to administer stimulants instead of applying leeches and blisters; thereby feeding in place of diminishing the inflammation, and so hurrying on the fatal crisis. A pulse, habitually slow, might, in inflammation, hardly attain the normal standard of frequency, and yet the system might literally be consumed by symptomatic excitement. The surgeon, aware of the possibility of such occurrences, is wide awake, never allowing himself to be thrown off his guard, whatever may happen.

The *countenance*, in inflammatory fever, is generally flushed, and often even unnaturally full, as if it were slightly tumid. The eyes are reddish, suffused, and frequently intolerant of light. The skin is hot and dry, the perspiration being kept in complete abeyance; and the extremities are usually so warm and uncomfortable as to be unable to bear any covering. When the excitement is excessive, the sufferer generally finds it impossible to maintain the same posture beyond a few minutes; he tosses about from side to side, and from place to place, in search of a cool spot.

The *respiratory organs* actively participate in the general disorder. The inspirations are increased in frequency, and are usually performed with a certain degree of labor; various kinds of râles are heard, and cases occur in which there is well-marked evidence of venous congestion.

The *digestive organs* always suffer more or less severely in inflammation. The tongue is variously affected: sometimes it is red and almost clean, but generally it is coated, either with a whitish, yellowish, or brownish fur, contracted, and somewhat reddish at the tip and edges; nearly always dry, and easily protruded, though often a little tremulous, especially when the person is of a nervous temperament. The taste is vitiated, or entirely abolished, the salivary secretion is suppressed, a thick, dark-colored mucus adheres to the lips, gums, and tongue, and there is a disagreeable arid feeling in the fauces and œsophagus. The thirst is intense, and can hardly be appeased by the most frequent and abundant draughts; the appetite, on the contrary, is usually destroyed, and hence the patient often loathes food, in whatever form presented. Nausea and a sense of gastric oppression, sometimes accompanied with bilious vomiting, are common attendants. The bowels are generally constipated, or alternately constipated and relaxed, distended with gas, and somewhat tender under pressure, the alvine evacuations being fetid, and variously altered in color and consistence. Along with this condition of the digestive tube there is usually more or less disorder of the liver, manifesting itself in excess, deficiency, or vitiation of its special secretions. Such a condition is very apt to be present in symptomatic fever consequent upon accidents and idiopathic inflammation in malarious districts. In what manner, or degree, the functions of the pancreas are affected in this disease, we are ignorant. The

probability, however, is that it suffers very much in the same way as the salivary glands of the mouth, which it intimately resembles in its structure and uses.

The changes produced by inflammation in the *renal secretion* relate chiefly to the quantity, color, and consistence of that fluid. In the normal state, the average quantity of urine, in the twenty-four hours, is from thirty-five to forty-five ounces, whereas in inflammatory fever it often does not reach one-half, one-third, or even one-fourth of this amount. Moreover, instead of being of a clear amber hue, as it naturally is, it is commonly of a deep red tint, and surcharged with an unusual quantity of extractive matter, mucus, and lithic acid, the latter of which, in a few hours, always falls to the bottom of the receiver, in the form of brick-colored sediment. The specific gravity of the secretion, varying from 1020 to 1024 in health, is also very much increased, and the odor is often more or less offensive from the presence of various kinds of animal substances. The chlorides, on the contrary, are commonly remarkably diminished, especially when there is much exudation with a tendency to cell growth. During the height of very acute inflammation, the fluid is often slightly albuminous, and even pervaded by tubular casts. A large quantity of urea is occasionally thrown off. Thus, in a case of pyæmia, recorded by Vogel, it amounted, in the twenty-four hours, in the febrile state, to 1235 grains. The excretion of the fluid is seldom much affected, although sometimes it is greatly increased in frequency. In traumatic inflammation, as after fractures, dislocations, and amputations, the bladder is occasionally so torpid as to require the aid of the catheter for the relief of its contents.

The *muscles* are generally the seat of great discomfort in this form of fever. Already during the stage of incubation the patient is harassed with a sense of lassitude, stiffness, and aching or darting pains, which, gradually augmenting in severity, at length constitute a source of great suffering. The pains in the lumbar region are particularly violent; they are always worse at night, and are often so intense as to deprive the patient completely of sleep. His back feels as if it were bruised, broken, bored, or sawed. Not unfrequently every joint is racked with pain, and the whole body is so exquisitely sensitive as to be intolerant of the slightest motion, pressure, or manipulation. It is this distress in the muscles that causes the patient such weary and painful nights, and which induces him to exclaim in the evening, " Oh that it were morning!" and in the morning, " Oh that it were evening!"

The suffering of the *brain* is evinced by a peevish and irritable state of the mind; by loss of sleep; by disagreeable dreams; and by occasional fits of delirium. In many cases there is more or less perversion of special sensation, as is evidenced by the distracting noises in the ears, the intolerance of light, the vitiated taste and smell, and the impairment of the sense of touch.

Finally, the *assimilative* powers being in abeyance, the body is gradually emaciated, and the strength fails in proportion to the impoverished condition of the blood and solids. Every tissue wastes, the fat is absorbed, and the countenance presents a shrunken, attenuated appearance.

Such is the ordinary course of events in inflammatory fever. If the morbid action do not proceed too far, or if the patient be unusually strong and vigorous, recovery is not only possible, but probable. The disease, and, along with it, the fever which it has induced, will gradually subside, the occurrence being announced by a diminution of restlessness, anxiety, and thirst, by a restoration of the moisture of the skin and mouth, and, in short, by a decided improvement in the condition of all the secretions. The sleep becomes more natural and refreshing, the appetite returns, the pulse and temperature descend to their normal standard, and the mind regains its accustomed equilibrium. The cessation of the fever often declares itself by the occurrence, either sudden or gradual, of a profuse sweat, to which the older pathologists applied the term critical, and by a general unlocking of all the secretions. In a word, the clouds which had so long obscured the horizon are once more succeeded by sunshine; disease has vanished, and health is regaining its supremacy.

If, on the other hand, the disease progresses, a downward tendency is gradually witnessed of evil, if not fatal, portent. The symptoms, losing their inflammatory type, now assume a *typhoid* character: the pulse becomes weak, soft, tremulous, and frequent, beating from one hundred and thirty to one hundred and sixty in a minute; the countenance assumes a peculiar shrunken aspect, denominated Hippocratic; the surface is bedewed with clammy perspiration; the extremities are inclined to be cold; the tongue is dry and covered with a brownish or blackish fur; sordes collect upon the teeth; hiccough and twitching of the tendons supervene; and there is rapid emaciation, with corresponding failure of the strength, and low muttering delirium. Recovery is still possible, although

doubtful; a well-directed plan of treatment, or even nature's unassisted efforts, may be sufficient to shake off the oppressive load, and enable the part and system to triumph over the ravages of the disease.

But typhoid fever is not always a necessary consequence of the inflammatory; it may, and often does, exist as an independent affection, coming on early in the attack, perhaps almost immediately after the commencement of the morbid action, and maintaining throughout a well-marked asthenic type. The most common cause of such an event is severe shock or loss of blood, occurring in an unhealthy, broken state of the system, or actual blood-poisoning, from the absorption of decomposing pus, or the operation of some specific virus, as that of malignant pustule, or that generated in the dead human body, and received by inoculation in dissection. In the more severe grades of erysipelas and carbuncle, the fever soon assumes an asthenic character, whatever may have been its original type, the system being speedily overwhelmed by the depressing influence of the morbific agent.

The occurrence of typhoid symptoms early in an idiopathic, specific, or traumatic inflammation, always portends evil, as it is denotive of great and rapid waste of life-power, which neither medicine nor food can, perhaps, successfully counteract. The nervous system is deeply involved in the morbid process; the blood is gradually deprived of its plastic properties; and, nutrition being at a stand, the body soon becomes pale, emaciated, and withered. The mind is early affected, and typhomania is generally a prominent symptom throughout. The vital forces diminish more and more, there is incessant muttering, with picking at the bedclothes, hiccough, and twitchings of the tendons, and the patient is so weak as to be unable to support himself upon his pillow. Exhaustion, in fact, is extreme, and a few hours generally suffice to close the scene.

There is another form of fever which is often seen during the progress of inflammatory affections, and to which the term *irritative* has not inaptly been applied, as it is generally met with in persons of a nervous, irritable temperament or habit of body. The best idea that can be given of it is that it bears the same relation to the nervous system that inflammatory fever, properly so called, sustains to the vascular; that is, the fever in the one case is characterized by irritability, or excess of sensibility, and in the other by plethora, or redundancy of vascular action. We find, accordingly, that in irritative fever there is a lively perception of pain, and an unusual exaltation of sensibility, both of the part and system; the mind is peevish and fretful, easily dissatisfied, and often filled with despondency and unpleasant foreboding; the pulse is quick, jerking, small, and sometimes wiry; the sleep is imperfect and disturbed by frightful dreams; the skin is hot, dry, and difficult of relaxation; the extremities are inclined to be cold; and there are frequently nervous rigors, followed by marked reaction and great restlessness; severe suffering is generally complained of in the loins and muscles; the slightest noise and light are annoying; and the head is distracted with severe pain, which often assumes a neuralgic character, and thus becomes a cause of great distress.

There are some low forms of inflammation in which the attendant fever nearly always assumes this peculiar type, being present almost from first to last. A good example of it is afforded in dissection-wounds, in certain injuries of the skull and brain, in phagedenic ulceration, in hospital gangrene, in sloughing chancres and buboes, in carbuncles, and in tertiary syphilis, in nervous debilitated subjects.

3. CHANGES OF THE BLOOD IN INFLAMMATION.

That the blood, which plays so important a part in the economy in health, should be seriously altered in inflammation, is what might naturally be anticipated, and what observation fully verifies. Sent with increased force and rapidity through every portion of the body, however constituted, or however remote from the heart; subjected to new actions and new affinities in the suffering structures, as if it were exposed to the heat of a laboratory, and deprived, in great degree, of the stimulus of the oxygen of the air, it is not surprising that it should be almost totally changed in its physical, chemical, and vital properties. The most important alterations which the fluid experiences relate to the fibrin and colorless globules, the quantity and number of which are always materially increased in every well-marked case of inflammation.

In healthy blood the proportion of fibrin to the entire mass is as 3 to 1000; in inflammation, on the contrary, it is generally very much increased, ranging from 6 to 8, from 8 to 9, and from 9 even to $10\frac{1}{2}$, according to the intensity of the disease and the general powers of the system. In what proportion the colorless globules are augmented in inflam-

mation is still an unsettled question; that their number is materially increased is sufficiently obvious, but whether the change, in this respect, is as great as in the fibrin is not ascertained. In addition to this increase in their number, there is a manifest increase of their bulk, as well as of their glutinous properties, thereby greatly promoting their tendency to cohesion to each other and to the sides of the vessels, which forms so striking a phenomenon in well-established inflammation.

This excess of fibrin and white globules is generally observable at an early period of the inflammation, and gradually increases until the morbid process has attained its maximum, when it begins to decline, and finally altogether disappears with the causes that induced it. Although it is most conspicuous in the higher grades of inflammation, there are few cases in which it is wholly absent, unless the disease is so slight as not to produce any serious structural changes, or material embarrassment in the force and rapidity of the circulation in the part and system. Gout and rheumatism, pleuritis, pericarditis, pneumonitis, hepatitis, splenitis, arteritis, and acute articular affections usually exhibit it in the most marked degree. It is also present, but less conspicuously, in inflammation of the skin, connective tissue, and mucous membranes. Where or how this change is produced is still a mooted question. It is probably mainly effected in the arteries and veins by the agitation which the blood experiences in its passage through the different parts of the body, its various ingredients being thus forcibly pressed and rubbed against each other, and against the sides of the vessels by the increased powers of the heart. A species of disintegration is thus established, which doubtless adds very greatly to the already existing excitement both of the part and system. The idea that attrition of the blood against the walls of the arteries is mainly instrumental in the production of the change in question derives additional support from what is observed when a horse is subjected to severe exercise upon the turf. If the animal be bled immediately after having been driven very rapidly, a great increase of fibrin and colorless globules will be found, evidently dependent upon the increased momentum of the circulation. Now this is precisely what occurs in inflammation; the greater the excitement of the heart or the more intense the morbid action, the greater will be the amount of fibrin and of white globules, and conversely.

The increase of fibrin and white globules in inflammation is attended with inordinate contraction of the crassamentum, and a separation of the red particles, leading to the formation of what is called the *buffy coat* of the blood. This consists of a whitish, bluish, or tallow-like pellicle upon the top of the crassamentum, which begins to show itself the moment the blood commences to coagulate, and attains its greatest height after the consolidation is completed. The thickness and density of the buffy coat are greatly influenced by internal and extrinsic circumstances, as the state of the system, the intensity of the disease, and the manner in which the blood is drawn. In some instances it is a mere delicate film, while in others it forms a firm layer several lines in depth. When the blood is much impoverished by protracted disease, long abstinence, or unwholesome food, the buffy coat is generally very thin, soft, turbid, and iridescent, forming a striking contrast with the characters exhibited in plethoric states of the system.

Of the various extraneous circumstances which influence the formation of the buffy coat, the most important, in a practical point of view, are the shape and capacity of the receiver, the size of the stream, and the motion to which the blood is subjected in its passage from the vein. It is most readily produced when the fluid falls into a deep, narrow vessel, from a large orifice, at the rate of two to three ounces in the minute. If the blood runs very slowly, or in a tiny stream, or if the stream, although quite bold, is received into a cold or shallow basin, the buffy coat will either not form at all, or so very imperfectly as to be scarcely appreciable. Sometimes the blood is merely sizy, the fibrin resting upon the top of the cruor like an imperfect bluish film.

The buffy coat essentially consists of plasma, blood-liquor, or fibrin, in combination with albumen and earthy salts. In fact, it is perfectly identical with the plastic matter that is poured in inflammation. By a little care it may easily be detached from the crassamentum; and, after being well washed in cold water and immersed in alcohol, it assumes not only the peculiar buff-colored aspect, whence it derives its name, but a very dense, firm consistence.

Of the manner in which the buffy coat is formed no very satisfactory explanation can be offered. It was formerly supposed to be owing to the more tardy coagulation of the blood, thereby permitting the red particles to disengage themselves from the fibrin and to sink, by their greater specific gravity, to the bottom of the crassamentum. But this was evidently a mistake; for it is now well ascertained that inflammatory blood, instead of solidifying more slowly than healthy blood, generally concretes very rapidly and firmly,

thus impeding instead of favoring the development of the buffy coat. The most plausible opinion perhaps is that the occurrence is due to the vital repulsion between the fibrin and red particles; or, what amounts essentially to the same thing, to the contraction of the former by which these little bodies are squeezed out of it, as water is squeezed out of a sponge, before the mass of the blood is fully coagulated. However this may be, it is impossible for the buffy coat to form unless there is a previous disunion of the principal constituents of the fluid, thereby establishing a predisposition to its occurrence. To ascertain whether this tendency to the development of the buffy coat exists, it is not necessary to employ a spoliative bleeding, but simply to draw a few drops of blood, and to look at it with the microscope, which will at once detect the slightest deviation from the normal standard. The red corpuscles will be observed to run almost immediately into clusters of piles or rouleaux, as represented in fig. 1.

In certain forms of inflammation and conditions of the system the blood is not only buffed, but cupped, the upper surface of the crassamentum exhibiting a hollow appearance,

Fig. 1.
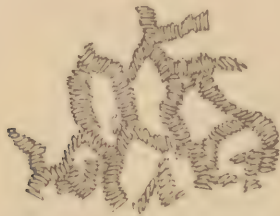
Reticulated Arangement of the Corpuscles in Inflammatory Blood.

Fig. 2.
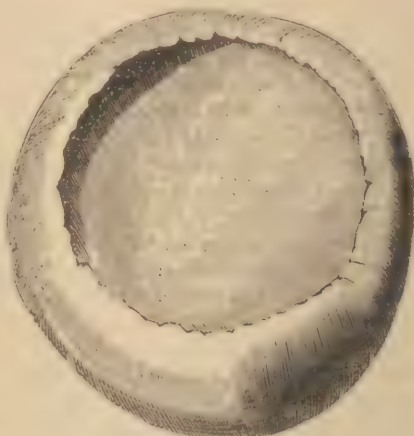
Buffy and Cupped Blood.

as if it had been scooped out with a knife. Such an occurrence usually denotes a higher degree of morbid action than the mere presence of naked fibrin on the top of the clot, and yet it is not unfrequently witnessed under circumstances which render it very questionable whether there is any inflammation at all, as in anemia, in scurvy, in chlorosis, and in profuse evacuations from the bowels, skin, and kidneys. To account for such anomalies, is generally not easy, but of their practical import every practitioner must be fully aware. In my private collection is a beautiful specimen, fig. 2, which I obtained by bleeding a young man laboring under pleuro-pneumonia, in which the buffed and cupped appearances coexist in a marked degree on both surfaces of the crassamentum.

It has not been ascertained what changes, if any, the red globules undergo in inflammation. That they are flattened and otherwise altered in their form is sufficiently obvious; and it is equally certain that they greatly diminish in number as well as in their coloring matter, during the progress of the morbid action, especially if at all severe or protracted, as is evinced by the pallor of the countenance and of the surface generally.

4. INTIMATE NATURE OF INFLAMMATION.

In the definition of inflammation, given in the early part of this chapter, no attempt was made to specify its true character or essential nature, as such a step would have been premature; but now that its various local phenomena have been pointed out and its constitutional effects traced, we are fully prepared to enter upon the subject, and to ask the question, What is inflammation?

To answer this question intelligibly, it is necessary to consider, 1st, the nature of the capillary vessels, in which the morbid action is mainly carried on; 2dly, the character of the blood, which, as already seen, is so singularly changed in this affection; 3dly, the part played by the nervous system, or, perhaps, more properly speaking, by the nerves of the affected structures; and 4thly, the condition of the tissues at the seat of the disease.

The capillaries are those minute canals which are everywhere interposed between the arteries and veins, and which are designed not merely as channels for the transmission of the blood, but also as organs for the elaboration of various kinds of fluids, as those of nutrition and secretion. In structure they differ from the arteries and veins only in the

fact that the finer ones consist of flat endothelial cells arranged in a tubular form, to which, in the larger, is superadded a tunic composed of a delicate network of fine fibrils, formed of the processes of the stellate cells which lie directly upon the vascular wall. With regard to their caliber, these vessels are divisible, for the sake of a more thorough comprehension of the subject, into two classes. The one embraces those minute tubules which, though invisible to the naked eye, carry a continuous stream of blood, so as to give the part in which they are situated, when examined with the microscope, a red appearance. The other group consists of vessels, the lumen of which is so small as to admit only a single globule at a time, and which it is often difficult to detect even with a strong magnifier.

Although the blood, as it circulates through the body, and immediately after it has been drawn from a vein of the arm, has the appearance of a homogeneous fluid, a careful examination shows it to consist of numerous elements, intended for widely different purposes in the economy. Coagulation separates it into two parts, one solid, and hence called the crassamentum; the other fluid, and called the serum. The crassamentum consists of a pale, whitish, transparent fluid, known as the blood-liquor, plastic matter, plasma, or coagulating lymph, and of minute particles, globules, or corpuscles, entangled in and suspended by it as the blood circulates through the body. The particles are of two kinds, the red and the colorless; the former, which impart to the crassamentum its red hue, are exceedingly abundant, and vary in size from the $\frac{1}{3000}$ to the $\frac{1}{3500}$ of an inch in diameter; they are of a flattened, biconcave, circular shape, and their office seems to be to absorb oxygen from the atmosphere and to convey it to the different parts of the system, to invigorate the organs and tissues. The colorless or white corpuscles—the leucocytes of certain authors—are much less numerous, but greatly multiply in inflammation; they are round, much larger than the red, and rough or finely granulated on the surface. What their precise office is is not determined, but it is certain that, at their expense, the red corpuscles can be regenerated; that they wander from the vessels into the surrounding tissues, where they proliferate; and that they play an important part in effecting certain plastic changes, if, indeed, they are not intimately concerned in the reproduction of impaired or lost structures.

In the vessels of the living body, the white globules have, apparently, no disposition to mingle with the red; on the contrary, they keep in close contact with the inner surface of the vessels, coasting, as it were, slowly along in the blood-liquor, outside of the general current. The red particles, on the other hand, pass quietly and gently along the centre of the vessels, regardless, so to speak, of the colorless, and in a much more rapid and lively manner, without any adhesion to each other, to the white particles, or to the coats of the containing vessels.

The essential elements of the inflammatory process, so far as we are able to comprehend them, are, 1st, slight contraction of the capillaries, with a retardation of the flow of blood; 2dly, dilatation of these vessels and an increased rapidity of the circulation; 3dly, exudation of blood-liquor, and emigration of white blood corpuscles; and, 4thly, a quiescent state of the capillaries, with complete stagnation of their contents. While these changes are going on in the interior of these vessels, important changes are wrought in the blood, both in regard to its consistence, its color, the arrangement of its globules, and the character of the plasma. Finally, the coats of the vessels themselves are seriously altered, being rendered abnormally soft and fragile, through fatty infiltration, and thereby temporarily incapacitated for the transmission of their contents. These various changes are so important as to demand separate consideration.

If a drop of rectified spirits, or of any mild stimulus, be applied to the web of the foot, the tongue, or mesentery of a frog, or the wing of a bat, the effect will be a slight contraction of the arteries, with a partial arrest of the flow of blood through the capillaries, the particles of blood moving to and fro for a few seconds, when they will be observed to regain their proper course, and to pass on as if nothing had occurred. If the irritation be more severe, as when a drop of tincture of capsicum is applied, the vessels, instead of diminishing, are instantly dilated, or if there be any contraction, it is so trivial and transient as to be inappreciable by the sight. However this may be, the dilatation soon becomes marked and decided, as is proved by the fact that the vessels now carry a much larger quantity of blood than naturally, the red particles being sent into them in increased numbers, as well as with increased force and velocity, evidently in consonance with the augmented action of the heart, which, beating perhaps from ninety to one hundred and ten in the minute, throws the fluid with extraordinary impetus into the inflamed part.

The disease advancing, the dilatation steadily augments, until, at length, the artery,

expanded to its utmost, is converted into a mere passive tube, palsied and crippled in its action, and therefore not only unfitted for transmitting its contents, but for performing any of its more delicate functions as an organ of nutrition and secretion. In other words, the rate of movement of the blood is again altered, primary acceleration giving way to retardation of the circulation.

In the condition now described, the capillary is not only greatly distended, but distinctly elongated and tortuous, sometimes almost knotty, as if affected with aneurismal enlargements, or veritable varices. Its coats are also abnormally soft and lacerable, from intermolecular changes in their structure.

The blood, the immediate cause of this dilatation, is literally impacted in the vessel, pressing everywhere upon its sides, and thus causing, by degrees, complete remora, stasis, or stagnation. The white and red particles, instead of pursuing an orderly, quiet, and independent course, as in the natural state, are now observed to be more or less intermixed, and so thoroughly crowded together that both are materially changed in their shape, being irregularly flattened, elongated, and distorted, as well as adherent to each other and to the sides of the vessel. When there is complete stoppage, the distinction between the two sets of globules is entirely lost, the blood forming a stagnant pool, of a dark homogeneous aspect.

These various changes, which are brought about gradually, not suddenly, may be studied with great advantage in what occurs in inflammation of the conjunctiva. If this membrane be irritated, as, for example, by the contact of a foreign body, there will be an immediate rush of blood to the part, with a great seeming increase of its vascularity. In a few minutes hundreds of vessels, previously invisible, will be seen shooting out in different directions, and connecting themselves with the sides of those that appeared in the first instance. These are not new channels, but old ones appertaining to the second class of capillaries, rendered evident by the intromission of red particles, which, in the healthy state, pass along so sparingly and in so slow and gradual a manner as to elude detection.

It is not to be supposed that the globules of the blood, as they are sent by the heart into the irritated arteries, are able, all at once, to pass through them without some difficulty. Instead of this, after having proceeded a certain distance, they rebound against themselves and against the sides of the vessels, so as to undergo a kind of oscillatory movement; but, gradually yielding to the force exerted upon them from behind, they are urged onward and onward until they reach the corresponding veins, into which, as their caliber is much larger than that of the arteries, they rush as into a vortex, and instantly disappear in the current beyond. A similar oscillatory movement of the globules of the blood is observed when the circulation is about to be reëstablished after it has been completely arrested. Some time is required for the detachment of these bodies, and when they have finally succeeded in effecting this, instead of passing on at once into the corresponding veins, they are propelled forward and backward until the diseased arteries are sufficiently dilated to admit of their escape.

When the morbid action is fully established, and at the same time very intense, without, however, there being as yet complete cessation of the circulation, the contents of the affected vessels not unfrequently break through their softened and lacerable walls, occasioning thus a veritable extravasation of blood.

Immediately around the seat of the greatest intensity of the morbid action, marked congestion exists, and the blood, consequently, passes along very slowly, and with difficulty. Beyond this point the phenomena are somewhat different; the excitement is less considerable, but still sufficient to cause active vascular determination; the blood moves in a continuous stream, and with extreme velocity, but being unable, as it approaches the focus of the inflammation, to make its way through the stagnant tubes, it is sent onward through collateral channels, now for the first time fairly opened for its reception. Thus it will be seen that, while at the centre of the morbid action stagnation occurs, and around this there is a sluggish circulation, an increased activity is going on in its neighborhood. The arteries leading to the affected part are distended, and pulsate strongly, but not with preternatural frequency.

The part played by the *nerves* in inflammation is very imperfectly understood. It is evident, however, that it is very important, although it is impossible to define its character or specify its degree. In traumatic inflammation, as well as in many cases of idiopathic, the vascular changes, which, as has been seen, consist essentially in dilatation of the vessels, with consequent diminution, retardation, and stasis of the circulation, cannot be referred to the blood itself, but must be seated in the vascular walls. Decrease of the resistance of the vessels to the pressure of the blood is probably due to perverted innerva-

tion.   The irritated sensory or nutrient nerves of the inflamed part impress the ganglionic centres in such a way that their action on the walls of the vessels through the vaso-motor nerves is diminished or inhibited, thereby producing lessened tone or reflex paralysis of their muscular fibres, as evinced by the dilatation of the vessels, and the consequent congestion of the tissues to which the irritated sensory nerves are distributed.   That the dilatation of the vessels and the hyperemia are not, however, necessarily of reflex origin, but that they may depend upon the direct influence of the irritating agent upon the walls of the vessels is demonstrated by the fact that they may be produced in the tongue of the frog after destruction of the nervous centres.

As the inflammation increases in intensity, the nerves actively participate in the morbid process, their substance becoming injected, softened, compressed, and otherwise altered, in consonance with the peculiarity of their structure and function.   The effect of such a change upon the welfare of the affected textures must be extremely pernicious, as it must materially diminish, if not entirely arrest, the nervous current, and thus weaken and prostrate their vital powers.

The joint agency of the nervous and vascular systems, in the production and maintenance of inflammation, has been happily illustrated by the researches of modern physiologists. Thus, for example, it has been ascertained, that, when the ophthalmic branch of the fifth pair of nerves is divided in the cranial cavity of a rabbit at the bridge of Varolius, inflammation is speedily lighted up in the surface of the eye, eventuating in opacity of the upper segment of the cornea.   What is still more remarkable is, that, when the nerve is cut on the petrous portion of the temporal bone, so as to involve the ganglion of Gasser, the resulting irritation is not only more violent, and much more deeply seated, but followed by complete disorganization of the organ.

Analogous effects ensue upon the division of the pneumogastric nerves.   When these cords are severed high up in the neck, the lining membrane of the air-passages assumes a dark color, the lungs are engorged with black blood, and an abundance of serosity is poured out into the parenchymatous texture, as well as into the pulmonary vesicles and the minute branches of the bronchiæ.   The pleura generally participates in the irritation, and there is almost always more or less inflammation of the stomach, with a suspension of the secretion of the gastric juice.

Animals in which the brachial plexus of nerves has been tied are soon seized with inflammation of the integuments of the remote parts of the limb, which gradually progresses until all the soft structures are invaded by gangrene.   A friend of mine removed a section of the peroneal nerve on account of a neuroma; the wound was long in healing, and two of the small toes sloughed before the patient recovered.   These facts enable us to explain certain circumstances that are noticeable in certain morbid states of the system.   A part, for instance, affected with palsy, is much less capable of withstanding the ordinary impressions of physical agents than one receiving its customary supply of nervous influence.   A burn in a paralytic person creates much more serious mischief than in a person in perfect health; and the same is true in regard to blisters and other irritants, the injudicious application of which often leads to the destruction of large portions of the skin and subjacent connective tissue.   There is little doubt that the inflammation of the bladder, which so frequently supervenes upon serious injury of the spinal marrow, is caused in a similar manner; that is, by the interruption of the natural supply of nervous fluid.

In whatever manner the parts are deprived of nervous fluid, it is presumable that they are brought under relations somewhat analogous to those of a frozen limb.   The temperature is lowered, the sensibility impaired, the process of nutrition perverted; in a word, the natural connection between the vessels and nerves is broken up, and hence that series of phenomena so characteristic of inflammation.

The saturation of the affected tissues with fluid exudation, through the escape of blood-liquor from the vessels, proceeds step by step with the diminution and retardation of the venous and capillary circulation, and forms one of the most essential characteristics of inflammation.   Although Bennett and Rokitansky had both been aware of the part played by the participation of the exudation of blood-liquor in the process of inflammation, it was not until recently that its importance in stimulating cell life, or modifying the healthy nutrition of local protoplasmic masses, was fully recognized.

Coincident with the exudation of blood-liquor and the other vascular changes above described, the white blood corpuscles, leucocytes, lymph corpuscles, nomadic or wandering cells, as these protoplasms are variously termed, greatly increase in number, and adhere to the inner surface of the vessels, forming upon it an almost motionless layer, while the red corpuscles circulate slowly along the centre in their accustomed channel.   Thus situ-

ated, the white corpuscles begin to wander out or emigrate into the inflamed tissues through the softened veins and capillaries, by virtue of the remarkable faculty which they possess of changing spontaneously their form and position, peculiarities which, from their similarity to those of amœbæ, are designated as amœboid movements. This faculty, as well as the diffusion of the white corpuscles in the tissues, was first demonstrated by Von Recklinghausen, without, however, his being aware of their vascular origin. Addison, in 1842, enunciated the fact that in inflammation the white corpuscles first pass into and then out of the walls of the vessels; and Waller, four years later, by experiments performed upon the tongue of the frog, confirmed the statements of his countryman. Although, subsequently, Stricker, of Vienna, discovered that the walls of the vessels are permeable both to the white and red corpuscles, it remained for Cohnheim, in 1867, to establish the correctness of these observations, by demonstrating conclusively that white blood corpuscles wander from the vessels into the irritated and inflamed tissues, and that, in incipient inflammation, all such morphological elements as cannot be distinguished from pus corpuscles, are derived from the blood, and not from the tissues. To Cohnheim, therefore, is due the credit of having correctly intrepreted his own observations, and of developing the researches of his predecessors. Having once infiltrated the inflamed tissues, these white corpuscles germinate, and become either fixed connective tissue cells, forming in conjunction with other tissue proliferation, the germ tissue of Rindfleisch, the granulation tissue of Virchow, or the plastic infiltration of certain pathologists; or, they are thrown off by the tissue in the form of pus; or, as observed by Hering, they may enter the lymphatic vessels, to be carried to distant points as lymph corpuscles; or, finally, they may reënter the veins and capillaries, as pointed out by Von Recklinghausen, the ultimate disposition of the protoplasm being determined by the intensity and duration of the morbid action, the texture or organ affected, and the state of the blood.

Not less important than the vascular changes in inflammation is the succeeding nutritive disturbance of the *cellular elements of the perivascular tissues*, due to the stimulating influence exerted upon them by the exuded blood-liquor, and manifesting itself by increase of substance, change of form, and proliferation, either through fission, germination, or endogenous generation. Proliferation, multiplication, or germination of local protoplasmic masses, accompanies inflammation of all organs and textures, in consequence of the assimilation by the germinal matter of an excess of new material derived from the blood-liquor. This activity of cell life has been observed in nearly all types of cells, both of non-vascular and vascular connective tissues. Thus, for example, the investigations already alluded to, of Stricker and of W. F. Norris, of this city, have demonstrated the proliferation of the germinal matter of the cornea corpuscles; Güterbock has shown the division of the nucleus of the cells of tendons; and Redfern, as is well known, first observed that the germinal matter of the normal cartilage cell is replaced by a mass of mobile cells, which are identical with white blood corpuscles. Similar hypernutrition of cell elements occurs in the vascular connective tissues. The researches of Stricker proved the increase by division of white blood corpuscles, and he has, moreover, confirmed the doctrine of Virchow that the fixed connective tissue corpuscles multiply in the same manner. Even in the capillary vessels, which are nothing more than tubular protoplasms, it has been ascertained by Beale, Stricker, Leidesdorf, and Shakespeare that similar growth and division take place; the former distinguished observer, moreover, believing, from the likeness of such dropped off bodies to white blood corpuscles, that they represent one of the modes of genesis of the latter. Finally, the participation of the muscle corpuscles in the process of inflammatory formations has been demonstrated by Virchow, Waldeyer, Weber, Weil, Spina, and Tschainski; and the nuclei of nerve cells, are said by Jolly, under certain circumstances, to increase in number.

Local disturbance of nutrition in inflammation is also indicated by the changes which occur in epithelial cells. Buhl and Remak discovered the endogenous proliferation of the germinal matter of the epithelial cells of suppurating mucous membranes; and the fission of the protoplasm of the epithelial cells of the corneal conjunctiva, and of the membrane of Descemet, has been observed respectively by Oser and Stricker. Analogous changes occur in the cells of the secreting glands, as is exemplified in those of the liver, which have been shown by Holm and Hüttenbrenner to participate in the formation of inflammatory products.

To what conclusions do these remarkable discoveries point? Simply, that the process of inflammation is attended with local disturbances of circulation and nutrition, the latter being dependent upon the former, which manifest themselves, first, by the escape through the walls of the thinned, softened, and dilated veins and capillaries of more blood-liquor than

is essential to normal nutritive changes ; and, secondly, under the influence of the assimila-
tion of an excess of new material derived from that fluid, by increased activity of the cel-
lular elements of the part, whether they be natural to it, or intruders from the bloodvessels,
as shown by their enormous multiplication.

The accumulation of young cells in the tissues thus gives rise to inflammatory new
formations, or plastic infiltration, which cannot be said, on the one hand, to be due exclu-
sively to the emigration and migration of white blood corpuscles, as advocated by
Cohnheim and his followers, or to be derived, on the other hand, exclusively from the con-
nective tissue corpuscles, as taught by Virchow and his school. On the contrary, both
elements participate in the process, as do the surface epithelia, gland cells, muscle corpus-
cles, nerve cells, and, in point of fact, all cells found in the tissue or organ affected. In
an irritated cornea, for example, it has been established beyond cavil that wandering cells
intrude into its substance and proliferate ; that the proper corneal cells germinate, and
that the epithelial cells of the anterior and posterior layers of that structure undergo simi-
lar changes. What is true of the cornea may be applied to other tissues, so that it may
be laid down as a general law that the inflammatory process is essentially characterized by
hypernutrition of the local masses of protoplasm influenced by it.

The migration theory of Cohnheim has recently been opposed by Stricker, who teaches
that the inflamed tissue returns to its embryonic condition by the conversion of its cells
and basis substance into an amœboid material, which subdivides into the small cells,
which are regarded by Cohnheim as emigrant white corpuscles, and by Virchow as multi-
plying connective tissue corpuscles. While I can see no objection to the acceptance of
the theory of the metamorphosis of the entire tissue into germinal or embryonic tissue, I
am not prepared to discard the view of the part taken by emigrant cells in plastic infiltra-
tion, which appears to me to have been settled beyond the possibility of refutation by the
observations of the most competent authorities.

Some of the changes which occur in the vessels and tissues in inflammation are admir-
ably depicted in fig. 3, for which I am indebted to Dr. E. O. Shakespeare, representing
the appearance of the mesentery of a rabbit in a state of acute inflammation of about
twenty-four hours' duration, as seen under a magnifying power of three hundred diameters,

Fig. 3.

Changes in the Bloodvessels and Tissues in Inflammation.

after the superficial endothelial covering has been removed. At the lower and right-hand
portion of the figure the elements and tissues are quite sharply defined, whilst in many
other places they are considerably out of focus. A portion of a network of capillaries, c,
crowded with numerous white corpuscles and a few red disks, and possessing swollen
nuclei, n, in its walls, which are somewhat too sharply delineated, occupies a level in the
thickness of the mesenteric tissue just beneath the endothelial covering. By focusing
slightly deeper, a layer becomes apparent, in which a small vein is discovered imme-
diately beneath a portion of the capillary network. Its axis is found crowded with
red blood corpuscles, a, whilst the inner surface of the wall, b, of the venule is covered
with closely-packed and adherent white corpuscles, g, several layers deep, among
which, scattered at rare intervals, are a few red blood disks. At k, and at similar
locations, swollen granular nuclei of the endothelial lining of the inner tunic, are plainly

visible, and it will be observed that analogous nuclei also cover the exterior surface of the wall of this minute vein. The venule is surrounded by a perivascular lymph space, *e*, which is filled with great numbers of leucocytes accompanied by a very few red disks. The wall of this space also is lined with endothelium, having one or more swollen granular nuclei, as seen at *i*. In one or two places leucocytes can be seen partly in and partly outside of the vein wall. The connective tissue, *d*, *f*, is in a condition of decided change. Many of the lymph spaces between the bundles of fibres are distended, as at *f*, with lymph rich in leucocytes, and the walls of these spaces can frequently be seen, as at *h*, to be lined with swollen granular endothelium.

Although Cohnheim demonstrated the identity of white blood corpuscles with those of pus, and showed that in acute inflammation pyogenesis was referrible principally to vascular origin, the fact must not be lost sight of that white blood corpuscles only are converted into pus corpuscles under certain circumstances. The question then naturally arises, what becomes of the inflammatory new formation—of the tissue infiltrated with crowds of young cells? Without entering into minute morphological details, it will be sufficient to say that, if the inflammation be slight, the cells disappear, partly by their conversion into connective tissue, partly by atrophy and disintegration, and partly by entering the lymphatics or bloodvessels. If the morbid process pass into solid plastic infiltration, the cells assume new forms, and are changed into fixed connective tissue corpuscles, while the gelatinous intercellular substance, or the original tissue, softened and swollen by exuded blood-liquor, is rendered more and more firm, until its final conversion into analogous tissue. If, on the other hand, the inflammation be more active, fluid inflammatory infiltration ensues, the cells proliferate and retain their form, the intercellular substance liquefies, and suppuration is said to exist. In what manner these different results are determined, why one tissue should recover rapidly and without suffering any visible signs of injury, while another is disorganized, are points which cannot be answered in the present state of our knowledge; but there is no doubt whatever that the process is a vital one, and that it is materially influenced by the intensity of the inflammation, by the nature of the affected structures, and by the condition of the blood.

A careful study of the inflammatory process leads to the conviction that, in its earlier stages, it is one of increased action, not only of the arteries, veins, and capillaries, but also of the tissues through which they pass. It may, therefore, be assumed that it has its seat in and around these vessels, no single factor being decisive, since the vascular and extravascular characteristics are so inseparably blended and interdependent that all must participate in its development. In summing up the essential elements of the process as they have here been described, it will be found that they consist, in the order of their succession, 1st, of irritation; 2d, of perverted innervation; 3d, of deranged circulation, as evinced, primarily by acceleration, consecutively by retardation, with the penetration of the vascular walls by blood-liquor and white blood corpuscles, and, finally, stasis; 4th, of textural or nutritive disturbances, due to hypernutrition of local protoplasms; and, 5th, of new formations.

If, when inflammation is in its incipiency, there is augmented action, it follows, as a natural consequence, that, when the disease is fully established, there must be corresponding debility. The capillaries are not only distended to their very utmost with non-oxygenated blood, but partially, if not completely, paralyzed; the tissues, at the seat of the disease, are surcharged with inflammatory products; all the normal functions are interrupted or suspended; and vitality itself is sadly impaired. At no long interval, the affected structures, especially if loaded with plastic deposits, evince a disposition to undergo the fatty degeneration, the earliest evidence of the occurrence being the confused appearance of the parts as revealed by the microscope, and by the presence of minute oil globules. If the fibrinous matter is spoiled, or transformed into pus, the quantity of oil greatly increases, and the tissues, acted upon by the absorbents and by chemical influences, are liquefied and devitalized. If, on the other hand, it becomes organized, the parts are in danger of being atrophied, as they are partially robbed of their nourishment, and choked as vegetables are choked by weeds.

Much discrepancy of opinion still exists among surgeons as to what constitutes inflammation; some, myself included in the list, believing that only a very slight degree of action is necessary, while others maintain that a very wide departure from the normal standard is essential. Some, indeed, assert that there is no inflammation, properly so called, unless there is suppuration, apparently losing sight of the fact that the disease very frequently proves fatal long before it has attained this crisis. Others, again, consider

fibrinous exudation an indispensable condition of the process.   As for myself, I am satisfied that it is not necessary that there should be even an effusion of plasma, or fibrinous exudation, much less suppuration, inasmuch as there are certain organs and tissues, in which, however violent the inflammation may have been, the most careful examination, microscopical and chemical, fails to detect after death the existence of fibrin in the affected structures.   It is only necessary to instance the arachnoid membrane, the aponeuroses, bones, cartilages, and nerves, in which this disease is frequently, if not generally, unattended by a deposit of plasma, especially in its milder forms, and in its earlier stages. The quantity of this substance, and the facility with which it is poured out, must necessarily be very materially influenced by the nature of the affected organs and tissues, some furnishing it much more readily, and in much greater abundance, than others.   Moreover, it requires very nice judgment, particularly in the living subject, to define the boundaries between congestion and inflammation, or to determine where the one terminates and the other begins.   Inflammation, in its incipiency, may be compared to a latent or smothered fire, kept in abeyance by a redundancy of surrounding material ; exudation cannot occur all at once ; some time is necessary to prepare the vessels for their new office : so it is with the flame in the furnace, it does not break forth immediately on the application of the kindling, and yet no one would thence conclude that fire was not actually present. Most of the disputes that has grown out of this question have arisen from a misunderstanding as to the amount of disease, or change in the affected part, that is necessary to constitute inflammation ; and it is obvious that there never can be any fixed or definite views upon the subject so long as this is the case ; nor can the question be satisfactorily settled, unless it be studied with reference to the nature and functions of the different organs and tissues of the body ; or, if the expression be allowable, the conduct and habits of the organs and tissues in their healthy and morbid relations.

Another source of difficulty, in the settlement of the question, is the fact that many practitioners are seemingly incapable of divesting themselves of the idea that inflammation must necessarily be treated by depletion, particularly by the lancet, leeches, purgatives, and starvation.   They find it apparently impossible to disconnect the two things, and yet it requires very little reflection, and certainly no great amount of experience, to show the erroneousness of such a conclusion.   Cases of inflammation are of daily occurrence which imperatively demand the use of stimulants from their very commencement ; and it is not going too far to assert that there is a period in almost every attack of the disease, in which, if it be at all severe, the patient will not be greatly benefited by the use of **brandy, wine, quinine, and nutritious food.**

Attempts have been made from time to time to invent theories of inflammation which should satisfactorily explain its character, the philosophers who have thus occupied themselves imagining that, with the aid of the microscope and other ingenious appliances, they could penetrate the very secrets of nature, by tracing out her most intricate and hidden operations, and the laws by which these operations are governed.   How futile all such attempts have been, and are likely to be, the history of the subject amply attests. Theory has succeeded theory, only to be ridiculed, and to work out, so to speak, its own fallacy and insufficiency.   The cautious observer contents himself with things as he discerns them, unbiassed by prejudice and conjecture, satisfied if he can occasionally pick up a pebble at the bottom of the great sea of knowledge.   Viewed in this light, and measured by this rule, the theories of one man are of no more importance than those of another ; as guides to clinical observation, and as aids to practice, they are utterly valueless.   It is fortunate for us in this matter-of-fact age that we are not obliged, as was the case in former times, in order to establish our claims as philosophers, to speculate about **the final causes of things.**

5. TREATMENT OF INFLAMMATION.

There are two leading indications in every case of inflammation when sufficiently grave to demand interference, the first being the removal of the exciting cause of the disease, and the second, the establishment of resolution.

In regard to the first of these points, it is obvious that, although the disease may be modified in its character, or rendered comparatively harmless, by treatment, yet it will be impossible to arrest it completely so long as the exciting cause is operative.   Thus, for example, in strangulation of the bowel, it would be folly to expect resolution of the inflammation so long as the strangulation which has produced it continues.   In such a case, one of two things must necessarily happen : either the sufferer must die from the effects of the disease, or he must be relieved by the knife, or by nature's operation, the

formation of an artificial anus. An inflammation of the lungs from the presence of a foreign body in the air-passages cannot be effectually cured so long as the foreign body remains, and keeps up the morbid action. A similar remark applies to inflammation of the bladder from hypertrophy of the prostate gland. The gland, acting obstructingly to the flow of urine, is the cause of the cystitis, and just so long as the enlargement remains will the disease continue, although, as stated above, it may be materially modified by therapeutic measures. But it does not follow, on the other hand, that the inflammation shall at once subside because the exciting cause has been removed. The malady may already have made such decided progress as to render the restoration of the part either impracticable, or possible only after a long time and after much suffering. In our attempts to get rid of the exciting cause by mechanical means, it is hardly possible to exercise too much care and gentleness, or to institute them too early. All officious interference, rude probing, or rough manipulation, must be avoided, lest we add, as it were, fuel to the flame, aggravating and perpetuating the disease. Splinters, nails, needles, pieces of bone, are extracted with the finger and forceps; the calculus is cut out of the bladder; the speck of steel is picked from the cornea; the aching tooth is lifted from its socket; all in as gentle and easy a manner as possible.

It is not always, however, that the exciting cause of the malady can be detected, however carefully or assiduously it may be searched for. Very frequently, indeed, the cause is latent, the morbid action having, to use a very common but unphilosophical expression, sprung up spontaneously. Such an occurrence is, of course, impossible; there must necessarily be a cause for every disease, although it may not be in our power to discover it; hence, to wait for its removal before we begin the treatment, might sadly endanger both part and patient.

The second indication is to establish resolution or to disperse the morbid action, with the least possible detriment to the structures and functions of the diseased parts. To effect this, various remedies may be necessary, some being addressed to the general system, others directly to the affected parts; circumstances which have given rise to the division of the treatment of inflammation into constitutional and local, or general and topical.

I. CONSTITUTIONAL TREATMENT.—The constitutional treatment of inflammation consists of bloodletting, cathartics, emetics, depressants, mercurials, diaphoretics, diuretics, anodynes, tonics, and antiperiodics, with the addition of what is known as the antiphlogistic regimen. It is not to be supposed, however, that all these means, or even a majority of them, are necessary in every case of this disease; so far from this being true, the morbid action often disappears spontaneously, or under the mildest and simplest remedies. Whenever constitutional treatment is demanded, it should be employed as early as possible, and with a determined hand, with the hope of arresting the inflammation before it has made any serious inroads upon the part and system. A few doses of medicine, judiciously administered at the outbreak of the disease, often do more good than twenty administered after it has attained its full development.

In speaking, as I shall have frequent occasion to do in the following pages, of the "antiphlogistic" treatment, I shall employ this expression, sanctioned by long usage, wholly in a conventional sense, and not in that of the older pathologists. An antiphlogistic remedy may, in the modern acceptation of the term, and in the sense in which I shall here use it, be mild or harsh, gentle or heroic, soothing or perturbating, according to the exigencies of each particular case of inflammation, injury, or disease. To treat all patients similarly, or on one uniform plan, would simply be absurd.

1. *Bleeding.*—General bleeding may justly be regarded as standing at the very head of the list of the constitutional remedies for inflammation, as it is at once the most speedy and the most efficient means of relief. The blood is usually drawn from one of the larger veins, and is permitted to flow until a decided impression has been made upon the system. When we consider the singular changes which this fluid undergoes in inflammation, the fact that it is sent in an unusually large quantity to the affected parts, and the circumstance that it is mainly instrumental in supporting the powers of the heart, it will not be difficult to form a correct idea of the importance of this operation, or of the influence which it exerts in combating morbid action. Its value was not overestimated by the older writers when they designated it as the "great remedy" in the treatment of inflammation; yet, strange to say, bloodletting, notwithstanding the high rank which it formerly occupied, as an antiphlogistic agent, has, of late, fallen very much into disrepute, not only in Europe, but on this side of the Atlantic, where it had at one time so many advo-

cates. A great change has come over the profession in this respect, within the last thirty years, a change which has so completely subverted all our preconceived notions upon the subject, as to render it very questionable, in the opinion of many, whether blood-letting is really ever required as an antiphlogistic. To what is this change due? Is it justly attributable, as has been asserted, to a modification of the type of disease, and to a gradual diminution of the strength of the American people? If it be, I have not been able to discover it. On the contrary, I am perfectly satisfied that inflammation possesses the same characteristics now that it did formerly, and it is equally clear to my mind that patients bear depletory remedies quite as well now as they did then. The change has been the result of the natural progress of events; of a more thorough and enlightened knowledge of pathology, diagnosis, and therapeutics; and, in some degree, of the pernicious influence which a few prominent and distinguished teachers have exerted upon the professional mind. Authority never fails to find followers, so much easier is it to be led than to think. The result is that bleeding is no longer fashionable; it is denounced by nearly every one. For myself, I cannot but regret this change, for it requires no argument to show its fallacy. If formerly we bled too much, too frequently, too copiously, and too indiscriminately, it is equally certain that the operation is not employed often enough at the present day. Many a deformed limb, blind eye, enlarged spleen, and crippled lung bear testimony, in every community, to the truth of this remark.

General bleeding is employed with different views. In the first place, it diminishes plethora and reduces the temperature of the body; secondly, it changes the qualities of the blood, and thus renders that fluid more healthy; thirdly, it weakens the powers of the heart and nervous system, and, consequently, the momentum of the circulation; and, lastly, it promotes the action of other remedies.

To obtain these effects in the most speedy and thorough manner, the blood should be taken from a large orifice in a large vein, the fluid running in a bold, full stream to the amount of at least three ounces in the minute, the patient being either in a sitting or standing posture at the time. If the operation be performed during recumbency, a much larger quantity will be required to be drawn before the part and system become sensible of the loss. When the object of the bleeding is merely spoliative, or intended to rob the vessels of an unusual amount of their contents, it may be done in this way; but even then the better plan will be to bleed in the semierect posture, reopening the vein a second and even a third time, if premature syncope interfere with the requisite abstraction. The difference in the effect of these two methods of bleeding is forcibly exemplified in conjunctivitis. A patient who is bled in the erect posture soon begins to feel faint, and to experience relief from pain, the eye at the same time exhibiting a blanched appearance, instead of the scarlet hue which it had a moment before; whereas one who is bled in the recumbent posture will retain his strength for a much longer time, and when, at length, he is rendered unconscious, the inflamed surface will be found to be still comparatively red. The impression, moreover, will generally be much more permanent in the former than in the latter, and the return, consequently, of the capillary injection more slow and less perfect.

The circumstances which call for this operation are, generally speaking, a hard, strong, full, and frequent pulse, a plethoric state of the system, and great intensity of morbid action. When such a conjunction exists, the surgeon cannot possibly go amiss in regard to the abstraction of blood, constitutionally considered. He may, perhaps, it is true, combat the disease without such recourse; by the use of antimony, purgatives, and other means, he may gradually bring down inordinate excitement, and thus afford the affected structures an opportunity of throwing off the burden with which they are oppressed; but if he wishes to make a prompt and decided impression, spoliative and depressive, upon the part and system, he can accomplish his object much more readily and effectually with the lancet than with any other remedy in the whole catalogue of antiphlogistics. If nauseants depress the heart's action equally with the lancet, they certainly do not produce the same effect in unloading the engorged capillaries at the seat of the inflammation, in restoring the circulation, and in reclaiming morbid structure. The operation of the one is gradual, and, at times, almost imperceptible; of the other, prompt and decisive, often cutting down the disease with a single blow; or, at all events, leaving it in a condition to be afterwards easily dealt with by other and more simple means.

When bleeding is required, the earlier it is performed the better. Ten ounces of blood taken at the beginning of an attack of inflammation will usually do more good than four times that quantity drawn after the disease is firmly rooted. Indeed, when a part is once overburdened with deposits, the salutary period for general bleeding may be

considered as being passed; for, although the operation may aid in reducing the force of the heart, in lessening temperature, and in promoting the action of other remedies, it certainly does not exercise the same happy influence upon the capillary vessels at the seat of the disease.

The quantity of blood drawn at a single operation may vary according to circumstances, the object being effect, and not ounces; for what would be a large bleeding for one person might be a small one for another. From sixteen to twenty ounces is a good average loss. Some individuals faint almost as soon as the blood begins to flow, while others can scarcely be made to faint, no matter how they are bled, or how much blood is drawn. The best plan, therefore, always is to continue the operation until it has made a decided impression both upon the nervous and vascular systems, avoiding actual syncope, but inviting an approach to it, and then guarding against the danger of excessive reaction.

In former times enormous quantities of blood were occasionally removed for the cure of inflammation. The memoirs of the French Academy furnish instances of the abstraction of three hundred ounces within a week; and equally astonishing examples have been recorded by British writers. The late Dr. John W. Francis, of New York, while laboring under a violent attack of croup and tonsillitis, was bled to the extent of nearly two gallons and a half in a few days. Such cases are remarkable as showing the wonderful power of endurance of the system, but are not to be held up as examples for the imitation of the modern practitioner. It must be understood, however, that inflammation often engenders a tolerance of bleeding. Thus, a nervous person who in the healthy state will faint from the loss of a few ounces of blood, will, when laboring under severe inflammation, bear with impunity the loss of perhaps ten times that amount. A similar tolerance of remedies is frequently established by disease. In delirium tremens, opium may be given in doses that would destroy half a dozen healthy persons; in pneumonitis, the stomach acquires an extraordinary degree of tolerance for tartar emetic; and in croup, iritis, synovitis, and in certain forms of syphilis, mercury may be given in large quantities without salivation, the system being seemingly insusceptible of its influence.

The first effect of a loss of blood upon the system is a sense of muscular debility. Presently, the individual begins to look pale, to see indistinctly, to be confused, to hear unnatural noises, and to feel light and giddy. If the flow be not immediately stopped, he will next become deadly sick at the stomach, convulsive tremors will pervade his limbs, the pallor of the countenance will increase to a deadly white, the respiration and pulse will nearly cease, and, if he is not supported, he will fall down in a state of unconsciousness. He has fainted. Such an effect is sometimes produced by the loss of a few drachms of blood; at other times not until many ounces have been drawn.

Syncope must be relieved gradually, not too suddenly, lest there should be undue reaction, by recumbency, by loosing the patient's clothes, by dashing cold water upon the face, or face and chest, and by a free access of air, obtained by throwing open the doors and windows of the apartment, aided, if necessary, by the fan. If consciousness do not soon return, the body is raised a little higher than the head, ammonia is rapidly passed to and fro under the nose, and sinapisms are applied to the extremities and the precordial region. Sometimes a draught of cold water will do more in reviving the patient than anything else. If, from idiosyncrasy or excessive loss of blood, the syncope assumes an alarming character, a stimulating enema is administered, and mustard is applied to the spine and chest, or, what is far more efficacious, the patient is suspended by his legs; but nothing is given by the mouth, unless it is certain that there is still some power of deglutition.

The immediate cause of syncope is an imperfect supply of blood in the brain, and the object in placing the patient, while in this condition, in the recumbent posture, is to enable the enfeebled heart to force the vital fluid more readily and freely into that organ. The reaction succeeding the stage of depression is characterized by a gradual return of the various functions of the body to their natural condition. The color reappears upon the cheeks, the heart and lungs act more energetically, the limbs regain their warmth, the surface often becomes slightly moist, and the mind recovers from its confusion. The only treatment necessary, during this stage, is proper vigilance, lest the reaction should become too vigorous; depression being rather favored, when the morbid action is at all severe, than rapidly relieved.

When the loss of blood has been disproportionally great to the powers of the system, the stage of depression may be succeeded by dissolution, or reaction may at length occur, the struggle for many hours, being, perhaps, one of life and death. This state may be induced

by one copious bleeding, or by several small ones, establishing an undue strain upon the vital current. It is characterized by unusual pallor of the countenance, feeble pulse and respiration, coldness of the extremities, clammy perspiration, frequent moaning or sighing, great thirst and restlessness, vigilance, and a tendency to delirium. While the system is in this condition, local congestion, followed by inflammation, is not uncommon, the structures most prone to suffer being the brain, the arachnoid membrane, and the lungs. Sometimes the symptoms here described are mixed up with those of feeble reaction; and then the countenance, perhaps, is flushed, the eye and ear are intolerant of light and noise, the respiration is quickened, the skin is hot and dry, and the pulse is thready, hard, and frequent. The proper treatment does not vary essentially in the two cases, our main reliance being upon opiates in full doses, milk punch, quinine, and the bromides, with elevation of the head and cold applications, exclusion of light and noise, and blisters, if there be marked tendency to local determination. Further bleeding would only cause further sinking.

In the abstraction of blood various circumstances are to be taken into consideration, of which the most important are the age, temperament, and habits of the patient, the character and progress of the disease, the structure and functions of the affected organ, and the peculiar constitution of the atmosphere. Young and robust individuals generally bear bleeding much better than children and aged persons, who often experience great exhaustion from the loss even of a few ounces. Old subjects, in particular, are prone to suffer in this way, the system being often a long time in reacting, while in not a few instances the operation is followed by sinking. Infants and children are also slow in recovering from the effects of bleeding; but reaction having taken place, there is much less danger of ultimate exhaustion. Persons of a nervous temperament are less tolerant of the loss of blood than the sanguine and bilious. Corpulent persons are bad subjects for the lancet, and the habitually intemperate are liable to be thrown into delirium tremens by it. The inhabitants of densely crowded cities do not bear the loss of blood nearly so well as the residents of the country. During the prevalence of epidemics, as erysipelas, scarlatina, diphtheria, smallpox, measles, and puerperal fever, bleeding in any form is generally inadmissible. Finally, the abstraction of blood must be practised with the greatest circumspection in all cases of inflammation likely to be at all protracted, and in all persons suffering under grave accidents, as fractures, dislocations, and lacerated wounds, attended with danger of excessive drainage and hectic irritation. After severe operations and injuries, excessive loss of blood may seriously interfere with the restorative principle.

The more violent the inflammation is, the more reason will there be, other things being equal, for early and active bleeding; so also if the organ affected be one highly essential to life. Blood is seldom taken when the inflammation is inconsequential as it respects its degree and seat, milder means generally sufficing for its subjugation.

In regard to the repetition of the bleeding, the practitioner must be governed, first, by the intensity and persistence of the morbid action; secondly, by the importance of the organ attacked; and, lastly, by the state of the blood. The disease continuing with little or no mitigation, there will be the same reason for bleeding as in the first instance, and the last may now, perhaps, be borne much better, the previous abstraction having, it may be, engendered a certain degree of tolerance. Intensity of action will be an additional reason for the act. The importance of the organ attacked must not be overlooked. An inflamed lung requires more energetic measures than an inflamed skin, and an inflamed skin than an inflamed finger. As it respects the buffy coat of the blood, its value as a sign of the necessity of a repetition of the operation has already been pointed out, and need not, therefore, be again discussed. Associated with a persistence of diseased action, and a vigorous state of the circulation along with unusual firmness of the buffy coat, it is of some practical importance, but much less than was at one time supposed.

In considering the expediency of repeating this operation in old, decrepit subjects, the action of the heart, as ascertained by the hand and ear applied to the chest, will generally be a safer guide than the pulse at the wrist, which, from the force with which the blood is impelled into the radial artery, often imparts to the finger a deceptive sense of hardness, fullness, and vigor wholly incompatible with the actual condition of the vital powers at that period of life.

It is a matter of great moment, practically speaking, that the use of the lancet is not at all incompatible, in the treatment of inflammation, with the employment of beef-tea, beef-essence, milk punch, and other concentrated articles of food and drink. On the contrary, there is every reason why, in violent attacks of disease, they should go hand in hand, or contemporaneously and successively, the lancet relieving the affected structures deluged

with blood, while the nutrients supply the necessary pabulum for the support of the system, and the promotion of repair during the struggle between life and death. The exhausting effects of a copious bleeding, performed early in the disease, in a strong, robust person, before any serious injury has been sustained by the affected structures, are generally easily and rapidly recovered from, very much as when a strong, robust, healthy person is bled. The globulin which, under such circumstances, suffers more than any of the other constituents of the blood, is then speedily reproduced under the influence of a well-regulated diet and other restoratives.

2. *Cathartics.*—Cathartics constitute a most important class of remedies in the treatment of inflammation, being even more valuable than bleeding, because of their almost universal applicability. Their exhibition, however, should always be premised by the abstraction of blood, provided the nature of the case is such as to admit of it. When this is contraindicated, they may be given at once, and there are few surgical affections in which they will not prove eminently beneficial. Cathartics are usually divided into purgatives and laxatives, which differ from each other merely in the one being more active than the other. The distinction, however, is not without practical importance.

Cathartics, considered as antiphlogistic agents, are employed for different purposes. In the first place, they may be administered simply to evacuate the bowels; secondly, to deplete the mucous membrane, and thus diminish the quantity of blood in the system; thirdly, to excite the action of the liver, salivary glands, and mucous follicles; fourthly, to produce a revulsive effect, or to set up a new irritation at a distance from the original one; and, finally, to stimulate the absorbents, thereby inducing them to remove inflammatory deposits.

The importance of using cathartics as mere evacuants cannot be too strongly insisted upon when it is considered that an overloaded state of the bowels is one of the most fertile sources of disease. Many of the so-called idiopathic inflammations evidently owe their origin to this cause, as is proved by the fact that a dose of active purgative medicine often promptly removes them, especially if administered at the commencement of the attack. An incipient ophthalmitis, tonsillitis, or fever, is frequently cut short in a few hours simply by clearing out the bowels, and thus ridding them of irritating fecal matter and vitiated secretions. Besides, so long as the bowels are constipated, it is impossible for other remedies to produce their specific effect, or for the various secretions to recover their natural tone.

Secondly, this class of remedies proves useful in depleting the bowels, by abstracting the serous portions of the blood from the vessels of the mucous membrane, and thereby diminishing the quantity of fluid in the general system. This practice is often beneficially adopted in inflammation of the large intestine, as in diarrhœa and dysentery, and in the milder forms of inflammation in various parts of the body, where the loss of the red particles of the blood is of questionable propriety. An ounce of Rochelle salt, or half a pint of citrate of magnesium, will often carry away from eight to twelve ounces of serum from the bowels in a few hours, with the greatest advantage as it respects the morbid action.

Thirdly, cathartics may be given with a view of stimulating the liver, pancreas, and mucous follicles of the bowels. There are few inflammations, or diseases of any kind, in which disorder of the liver does not play a conspicuous part, either in exciting or maintaining morbid action. The quantity of fluid poured out by this organ, in health, in the twenty-four hours, probably amounts to nearly forty ounces, and it is, therefore, not difficult to form a tolerably correct idea of the ill effects that must result from the interruption, modification, or complete suspension of its functions. The irritating material which it is destined to eliminate being retained in the blood, there must arise, as a necessary consequence, serious derangement of the nervous and vascular systems, as denoted by the excessive lassitude, headache, excited pulse, and other symptoms, so conspicuous in disordered states of the liver. But a diminished supply of bile is not the only difficulty: on the contrary, the fluid may be secreted in unnatural quantity, and yet, if vitiated in quality, the effects will hardly be less serious. The pancreas, too, may have its functions deranged, which the well-directed cathartic may readily restore to their normal condition. Of the vast influence exercised upon the health by the mucous follicles of the alimentary canal, it is hardly possible to form any adequate conception. Existing, as they do, everywhere in vast numbers upon the mucous surface, the suppression of their functions, even for a short time, cannot fail to be followed by local inflammation in different parts of the body, or the material aggravation of it, if already lighted up. Hence, remedies calculated to restore, modify, or improve the secretions of these several structures constitute important objects of treatment, not only as preventives, but as means of cure.

Fourthly, the administration of cathartics proves useful on the principle of revulsion, metastasis, or counter-irritation, by establishing a new action in a part more or less remote from that originally affected. During the operation of a brisk purgative, as well as for some time after, there is an unnatural afflux of blood to the alimentary canal, by which the suffering organ is temporarily relieved of vascular turgescence, on the principle that two morbid processes cannot go on, to any extent, at the same time. This operation may be intermittent or permanent, according to the character of the cathartic and the mode in which it is exhibited. In inflammation of the head, throat, eyes, and, in fact, of the supradiaphragmatic portions of the body generally, this principle is never, for a moment, lost sight of by the practitioner, inasmuch as it constitutes a most important element of treatment.

Finally, cathartics, by clearing out the alimentary canal, and restoring the secretions, pave the way for the more successful action of other remedies, as diaphoretics, anodynes, diuretics, and sorbefacients. They exert, in this respect, very much the same influence, only in a slighter degree, as venesection and leeching, diminishing the volume of the circulating mass, and diverting the blood from the suffering organ. Relieving obstruction, restoring secretion, and establishing new action, they enable the absorbent vessels to recover from their torpor, and to render themselves useful in removing inflammatory deposits.

Cathartics are particularly valuable in inflammation of the brain and its membranes, the eye and ear, throat, respiratory organs, liver, skin, and joints. In gastritis, enteritis, peritonitis, cystitis, wounds of the intestines, and strangulated hernia, they are either contraindicated, or exhibited with the greatest possible circumspection, and only in the mildest forms. In most, if not in all, of these affections, the best purgative is the lancet, aided by large anodynes, either alone or in union with calomel. Tranquillity, not perturbation, is what is sought, on the principle that whatever excites peristaltic action must prove prejudicial to the inflamed surface.

Cathartic medicines must not be exhibited merely with a view of correcting disordered alvine evacuation. Such a procedure could not fail to prove injurious. The action of these remedies is perturbating, and therefore subversive of healthy function; hence, it would be unreasonable to expect that the discharges should be entirely natural so long as they are exhibited. The more frequently they are administered the more likely will this be the case.

When these medicines act tardily, their operation may be aided by injections; and cases occasionally occur where the latter remedies may advantageously, if not entirely, take the place of the former.

The number of purgatives and laxatives is very great, and the surgeon may therefore give himself considerable latitude in the choice of his articles. A few, however, either alone, or judiciously combined, will answer his purpose in nearly every case. When a merely evacuant effect is desired, nothing is better than a dose of castor oil, rhubarb, or jalap; the saline cathartics produce watery passages; calomel, blue mass, and gray powder act specifically upon the liver; and when an irritating, revulsive, or metastatic effect is wished, the proper articles are compound extract of colocynth, scammony, gamboge, aloes, and podophyllin. In external inflammations, as well as in inflammations of the supradiaphragmatic organs generally, one of the most useful cathartics, as I have found from long experience, is an infusion of senna, or of senna and Epsom salt. It operates not only promptly and powerfully upon the bowels, but also upon the liver, stimulating this organ to increased action, in a manner hardly inferior to calomel and blue mass. The only objection to its exhibition is that it is apt to gripe, but this tendency may usually be effectually counteracted by combining with it some carminative. Leptandra is also a good cholagogue, without so decided a purgative effect as pertains to calomel and senna, but this may be increased to any desirable extent by the addition of rhubarb, jalap, or podophyllin. Rochelle salt is at once an agreeable, cooling, and efficient laxative. Croton oil is rarely used, except to relieve obstinate constipation, and then only with the greatest caution.

Injections, clysters, or enemas, may be prepared of various articles, as gruel and common salt, water and mustard, castor oil, spirit of turpentine, infusion of senna, jalap, and other substances, according to the intended effect. An excellent enema, prompt and efficient in its action, may be made of one quart of soapsuds and two ounces of vinegar. Whatever material be used, the important rule is to mix with it a sufficient quantity of fluid, warm or cold, to distend the lower bowel. It may be administered with a hard rubber or a common pewter syringe, having a long nozzle, and capable of holding at

least from sixteen to twenty ounces; or, when there is obstinate constipation, with an ordinary stomach tube. The patient should lie upon his side or belly during the introduction of the instrument, and care taken that he be properly held, especially if he be delirious or otherwise unmanageable. A number of cases of perforation of the rectum caused by the reckless use of the syringe are upon record.

3. *Mercury.*—The reputation of mercury, as an antiphlogistic, has long been established. Although the precise mode of its action is still imperfectly known, its beneficial effects are well understood. Its virtue in controlling inflammation is hardly inferior to that of the lancet and of tartar emetic, while, during the decline of the disease, as a powerful sorbefacient, or promoter of the removal of morbid deposits, it is without a rival in the materia medica. It may, therefore, be given during the height of the malady with a view of arresting its progress, and subsequently, after this object has been accomplished, for the purpose of getting rid of effused fluids, or reclaiming oppressed and disorganized structure. The efficacy of the remedy, in both these relations, is particularly conspicuous in the phlegmasias of the fibrous and fibro-serous tissues, in gout and rheumatism, synovitis, carditis, arteritis, hepatitis, splenitis, pneumonitis, laryngitis, iritis, orchitis, osteitis, and in syphilis. It is less apparent, although not without its value, in inflammation of the brain, the skin, and mucous membranes, bronchitis, nephritis, cystitis, and metritis.

It is rarely that the treatment of inflammation is commenced with the use of mercury. It is only in very urgent or neglected cases that this rule is departed from, the potency and activity of the remedy being always augmented by previous depletion. Whenever, therefore, there is evidence of plethora, bleeding and purgation should precede its use. There is, so to speak, a mercurial point in inflammatory affections, prior to which the employment of this remedy either proves positively injurious, or greatly disappoints expectation. This point is characterized by softness of the pulse, a relaxed condition of the skin, moisture of the tongue, and a general tendency to restoration of the secretions. Administered during the height of the morbid action, when the whole system is enveloped, as it were, in flame, it can hardly fail to act as an irritant, and to increase the general excitement. For want of attention to this rule, a great deal of mischief is often done, and a remedy, otherwise of inestimable value, permitted to fall into disrepute.

Of the manner in which mercury acts in relieving inflammation, there is, as already intimated, no very definite information. That it affords powerful aid in controlling the action of the heart and vessels, both large and capillary, is unquestionable; but how this effect is produced, whether by any direct sedative impression it may exert, or by merely correcting the secretions, is still a mooted point. Nor is there any positive information in regard to the changes which mercury induces in the state of the blood. It is well known how greatly the properties of this fluid are modified by inflammation, what increase there is of fibrin and white globules, and how promptly, in many cases, these changes are corrected by the judicious use of mercury; but in what manner this is effected is, in the present state of the science, altogether inexplicable.

When the exhibition of mercury is pushed to the extent of active ptyalism, speedy changes are induced both in the solids and fluids. The patient soon becomes thin, haggard, and enfeebled, and the blood is rapidly changed in its properties, the fibrin being diminished, approximately, by one-third of its amount, the globulin by one-sixth, and the albumen by one-seventh, at the same time that it is surcharged with heterogeneous and irritating matter, the product of decomposition.

During the decline of inflammation, and, indeed, in many cases long after the morbid action has been completely checked, the judicious use of mercury is of the greatest advantage in effecting riddance of the morbid products. Of the manner in which this is done, direct ocular demonstration is occasionally afforded in some of the external phlegmasias. Thus, in iritis, if the system be placed under the influence of mercury, the effects of the remedy are rendered obvious by the daily progress which the affected structures make in freeing themselves of the plastic matter that was effused during the height of the inflammation, and which frequently proves so destructive to them by the changes which it induces in the pupil. Similar effects are witnessed in inflammation of the cornea, attended with interstitial deposits. The opacities which result from these deposits often vanish in a short time under the influence of slight ptyalism, the effect being frequently apparent before the action of the medicine is fairly developed. In orchitis, after the disease has measurably subsided, the swelling and induration are, in general, promptly dispersed under the use of mercurials, aided by rest, light diet, and purgatives. In all these, and similar cases, the beneficial effects of the agent are evidently due to its sorbefacient properties, or to the

manner in which it stimulates the absorbent vessels, compelling them to remove the products left by the previous action.

Administered merely as a sorbefacient, the effects of this remedy are often insensible, its action being exerted in a very slow and gradual manner, yet hardly any the less efficiently. This kind of action is particularly desirable in chronic diseases, attended with a crippled condition of the tissues from semiorganized deposits, and an enfeebled state of the general system. Under such circumstances, active mercurialization is altogether inadmissible, from its irritating and prostrating effects; while a more gentle and persistent course is often followed by the greatest benefit, the gums being merely touched, or rendered slightly red, tumid, and tender, as an evidence of the silent operation of the remedy.

The best form of exhibition of the remedy is calomel, blue mass, or mercury with chalk. When a prompt and powerful impression is desired, as when there is high inflammatory action, likely to prove speedily overwhelming in its effects, not only threatening structure but life, the medicine should be given in large and frequently repeated doses, so as to keep up a decided and well-sustained influence. For this purpose the best article is calomel, in does of three to five grains, administered every three, six, or eight hours, until we have attained the object of its exhibition. When the case is at all urgent, as, for example, in croup, pneumonitis, or carditis, no time is to be lost; whatever is done must be done quickly, with a bold, vigorous hand; the remedy must be given in full, not in small, insufficient quantities, or in a faltering, hesitating manner. There is but a short step between the disease and the grave, the struggle is one of life and death, and the victory must be accomplished, if accomplished at all, at all hazard, present or future. When the disease is less violent, or the organ involved less important to life, the medicine is exhibited in smaller doses, and at longer intervals, and then, too, instead of calomel, the milder forms may be used, as blue mass, or gray powder. When a chronic or insensible impression is desired, the bichloride may be given instead of calomel or blue mass, or the latter may be employed in smaller doses. Other forms of mercury, to be mentioned hereafter, as the iodide, and cyanide, are often beneficially prescribed in chronic diseases of the skin, in glandular enlargements, in chronic affections of the joints, and in tertiary syphilis. Mercury with chalk, or gray powder, is a great favorite with some practitioners in inflammatory diseases of children and aged persons; but I rarely use it, having frequently found it to nauseate and to be unworthy of reliance.

To prevent the mercurial from running off by the bowels, it is usually necessary to combine it with a certain quantity of opium, as a fourth of a grain, half a grain, or even more, with each dose, according to the particular exigencies. In children, and in all cases affecting the brain, opium should be given with great caution, especially during the violence of the morbid action. When the skin is hot and dry, the mercurial should either be entirely withheld until further depletion has been practised, or it should be united with some diaphoretic, as tartar emetic, ipecacuanha, or Dover's powder. Griping, which is so liable to occur during the progress of the treatment, should be counteracted by carminatives and laxatives, as oil, salts, or magnesia.

The administration of so potent a remedy as mercury should be most faithfully watched. No judicious practitioner uses it heedlessly or sakelessly. He knows that it is a remedy for good or for evil, and he, therefore, employs it wisely and properly; opportunely, not out of time. As soon as he discovers, by the fetid state of the breath, the red and tumid appearance of the gums, the metallic taste, and the increased flow of saliva, that the object of its exhibition has been attained, he either omits it altogether, or gives it only in very small quantity, and at long intervals. He does not persist in its administration, as was once the custom, until the tongue is too big for the mouth, the teeth drop from their sockets, articulation, deglutition, and even breathing are almost impossible, and the countenance presents a distorted and hideous aspect; he simply touches the gums, maintaining the impression thus made, if necessary, on account of the continuance of the morbid action, or letting it die out, if the disease has been arrested.

There are certain persons who, from idiosyncrasy, or the former use of mercury, cannot take this medicine, even in the smallest quantity, without being violently salivated. To avoid this occurrence, so exceedingly disagreeable both to the patient and the practitioner, due inquiry should always be made with a view of ascertaining this fact, previously to the administration of the remedy. On the other hand, there are persons who cannot, under any circumstances, be constitutionally impressed with mercury, however largely it may be used. They are mercury-proof. It apparently fails to enter the system in any form, combination, or mode of exhibition. In such cases, and also when the system is not as prompt in responding to the effect of the medicine as is desirable, the article should be conjoined with some

nauseant, as ipecacuanha or tartar emetic, so as to produce more thorough relaxation of the system. The operation of the medicine may also be aided with frictions of oleate of mercury upon the groin, the inside of the thighs, the arm, and axilla, thrice in the twenty-four hours, for fifteen minutes at a time, the inunction being performed near a fire, with the hand well protected with a pair of gloves, otherwise the assistant may salivate himself long before he succeeds in affecting the patient. One drachm of the oleate will suffice at each application. Employed in this way, the effect is sometimes more rapid than when the medicine is given internally, although the constitutional impression is more mild and evanescent.

Not unfrequently, especially in persons of very delicate skin, the effect of the remedy may readily be obtained by wrapping around each arm a broad piece of flannel, well smeared with the oleate, and worn until the gums are slightly tender, a small quantity of the preparation being added once a day.

Rapid ptyalism may be effected by the use of suppositories, composed each of a drachm of strong mercurial ointment, rendered stiff with a little tallow, and inserted into the rectum every eight hours, the bowels having been well emptied previously, and then locked up with a full dose of opium in order to secure retention. The gums under this remedy occasionally become quite tender within the first twenty-four hours, and in hardly any case does the time required exceed two days.

There are various circumstances which altogether contraindicate the use of mercury in almost any form. Persons of a strumous habit of body, the old, the infirm, the ill-fed, the badly-clothed, and the anemic, are particularly prone to suffer from the use of the remedy, even when exhibited in very small quantity. It is in subjects of this description, more especially, that we witness those frightful ravages of the mouth, teeth, jaws, and cheeks, formerly so common in this country from the reckless and indiscriminate use of this class of medicines.

Finally, if salivation should accidentally set in, the best remedies will be astringent gargles, cooling laxatives, emollient applications to the face and neck, sulphate of atropia, and the liberal use of anodynes, to allay pain and nervous irritation. The lotion which I have found most efficacious is a solution of Goulard's extract, in the proportion of one drachm to eight ounces of water, used every hour or two, the only objection to it being that it discolors the teeth, an effect which, however, soon disappears of its own accord. Gargles of alum, tannic acid, copper, zinc, creasote, and other astringent substances also prove beneficial, especially if not employed too strong. When the inflammation runs very high, leeches to the throat and jaws are indicated; and it may even be necessary to scarify the tongue, to prevent suffocation. Excessive fetor is allayed with chlorinated soda and other suitable means.

Next to atropia, the best internal corrective of salivation, perhaps, is chlorate of potassium administered in doses of fifteen to thirty grains three or four times a day, in a large quantity of sweetened gum-water, or lemonade, to render it more soluble. This medicine seems to act with peculiar efficacy upon the digestive organs, and may often be advantageously resorted to as a prophylactic during the exhibition of mercury. It may also be beneficially employed as a gargle, from one to two drachms being dissolved in a pint of water, and the solution used every two or three hours. In very intractable cases of ptyalism, an emetic of ipecacuanha, morning and evening, often answers when almost everything else has failed.

4. *Emetics.*—Emetics are not as often used now as they were formerly in the treatment of inflammation, their employment having been, in great measure, superseded by cathartics and other evacuants. Their exhibition, at the present day, is limited almost exclusively to cases in which there is marked gastric and biliary derangement, as denoted by the nausea and vomiting, the headache, lassitude, and pain in the back and limbs, which sometimes so greatly oppress the patient in the earlier stages of his illness. When these symptoms are present, and there is no contraindication, an emetic often acts like a charm, not only ridding the stomach of irritating matter, but allaying vascular excitement, promoting perspiration, and, in fact, unlocking all the secretions. The great Desault and his pupils were particularly fond of this mode of treatment in erysipelas, and I have often witnessed its beneficial effects in this and similar diseases. Emetics are, of course, not used in the phlegmasiae of the subdiaphragmatic organs, as gastritis, enteritis, peritonitis, hepatitis, and cystitis, inasmuch as the concussion caused by their action would inevitably prove injurious. For the same reason they are withheld in wounds of the intestines,

in hernia, in fractures, and in dislocations. In cephalic and cardiac diseases they are also carefully avoided.

The best forms of administration are tartar emetic and ipecacuanha; common salt, alum, and ground mustard also occasionally answer a good purpose, their effect being generally prompt and efficient. Apomorphia is a direct emetic, and when given even in a dose not larger than the one-fifth of a grain often acts with great vigor. Whatever substance be employed, it should be followed by large draughts of tepid water, chamomile tea, or infusion of valerian, the latter being particularly beneficial in nervous and hysterical subjects. As a general rule, tartar emetic should never be given, on account of its sedative and irritating effects, to very young children and to persons enfeebled by age and disease.

5. *Depressants.*—Depressants, sedatives, or nauseants, are justly entitled to a high position in the scale of antiphlogistic agents. As their name implies, they are remedies which, by lowering the action of the heart, lessen the momentum of the circulation, and diminish the flow of blood to the affected tissues. This, however, is not the only good they are capable of doing; by the impression which they make upon the nervous and sanguiferous systems, they are instrumental in reëstablishing and in improving the secretions, and in thus indirectly controlling the morbid action. There is, in fact, not a single organ which does not feel, to a greater or less extent, their influence, or which is not brought, more or less, under their dominion. The effect of this operation is often witnessed during the exhibition of tartar emetic in nauseating doses, in the relaxed skin, the softened pulse, the moistened tongue, and the pallid countenance, all bearing testimony to the universal impression of the remedy. Judiciously employed, depressants are among the most valuable and efficient antiphlogistic means we possess, and they have the advantage that they may often be used without any preliminary depletion. Their beneficial effects are particularly conspicuous in inflammation of the respiratory organs, the heart, the eye, the joints, and the fibrous structures, as well as in certain forms of inflammation of the skin and connective tissue. In many of these affections, if indeed, not in all, they have almost entirely superseded the use of the lancet and other evacuants, their controlling influence over the morbid action being generally very decided. Their efficacy is hardly less apparent in many of the diseases of the subdiaphragmatic viscera; but their exhibition here demands greater care and vigilance, as their emetic effects could not fail to prove prejudicial. Their employment is particularly adapted to the treatment of acute inflammation of young, robust subjects, whose systems require to be rapidly impressed in order to arrest the progress of their diseases. Infants, and children, the old, infirm, and decrepit, do not bear their use well, and often sink under their injudicious administration.

The most trustworthy depressants are tartar emetic and ipecacuanha, aconite, veratrum viride, gelsemium and digitalis, the last of which, however, holds a very subordinate rank. Of the depressing effects of bleeding I have already spoken, and pointed out the circumstances under which they may be most readily produced.

Tartar emetic, as a depressant, may be administered in doses varying from the eighth to the fourth of a grain repeated every two, three, or four hours, according to their impression, which should be steadily maintained until the object of the administration of the remedy has been fully attained. It will generally be safest to begin with a small quantity, and to increase it gradually if it be found to be well borne by the stomach. Sometimes the first few doses, even if small, produce pretty active emesis; but this, so far from being injurious, commonly proves highly beneficial, by relaxing the system and opening the emunctories. By and by gastric tolerance will be established, and then the remedy will often be borne in extraordinary quantities, although it is never employed in the enormous doses recommended by Rasori, Thomasoni, and other disciples of the Italian school. In this country, indeed, we seldom give as much at a single dose as half a grain, the average quantity rarely exceeding one-half or one-third of that amount. The Italian practitioners, on the contrary, often gave five, ten, and even fifteen grains at a dose.

When antimony is administered in a proper and persistent manner after the powers of the system have been lowered by general bleeding, its effect is to depress the heart's action still further, to relax the skin, to prevent the tension of the vessels, and to favor the passage of the blood at the seat of the disease. A continuance of the remedy increases the watery portions of the blood, and diminishes the quantity of solid matter, especially the amount of fibrin.

The beneficial effects of tartar emetic, as a depressant, may often be greatly enhanced by the addition to each dose of a small quantity of the salts of morphia, just enough to produce a calming and diaphoretic impression. Such a combination is particularly serviceable in nervous, irritable persons, and in subjects who have been debilitated by intemperance and other causes. When the article, given by itself, is productive of vomiting, it should never be used in any other way. In children, too, such a mode of exhibition is, as a rule, indispensable. Sometimes the medicine may be advantageously administered along with the neutral mixture.

The dose of *ipecacuanha*, as a depressant, varies from a fourth of a grain to a grain and a half, according to the age of the patient, and the article may be used either alone or in combination with an anodyne, as, indeed, is usually found to be best. A nauseant effect may be kept up in this manner almost as long as may be desired, but the impression is less pervasive and far inferior, in every respect, to that of tartar emetic. On this account, however, the medicine is peculiarly adapted to the treatment of inflammatory affections of children, who, as already stated, seldom bear the operation of antimony well.

Whichever of these two articles be employed, it will be well to withhold all drinks from fifteen minutes to half an hour after the exhibition, otherwise they will be very liable to cause vomiting. At the end of this time, however, diluents, cool or tepid, may be used with the greatest benefit, from their tendency to promote relaxation and secretion.

Aconite is a powerful antiphlogistic. The form in which it is usually exhibited is the saturated alcoholic tincture of the root, prepared according to Fleming's formula, the dose of which is from one to five drops, repeated every two, three, or four hours, until it has produced its peculiar depressing effect. The best, because the safest, plan is to begin with a small quantity, and to increase it gradually and cautiously until it brings down the pulse, which, in the course of a few hours, often descends twenty, thirty, forty, and even fifty beats in the minute, the surface, at the same time, becoming bathed with perspiration. In large doses, it is powerfully sedative and anodyne, but it should never be given in this way, on account of its prostrating influence. It is particularly adapted to neuralgic, gouty, and rheumatic affections, and to the higher grades of traumatic fever; and my practice generally is to combine it with sulphate of morphia, as this insures a more prompt and beneficial action than when given by itself.

Veratrum viride exerts a powerful influence upon the action of the heart and pulse, very similar to that of aconite, only, if possible, still more certainly. The dose of the saturated alcoholic tincture of the root, the form of the medicine most generally employed, is from five to eight drops, repeated every two, three, or four hours, until it has sensibly reduced the force, and frequency of the pulse, when it is either suspended or given in smaller quantity. As veratrum viride is an article of great potency, it is impossible to be too careful in its use. Carried too far, it causes nausea and vomiting, excessive prostration, faintness, vertigo, dimness of sight and other dangerous symptoms. It is applicable to the same class of cases as aconite, and may be given either by itself or in union with morphia, or morphia and tartar emetic. The best means for counteracting its depressing effects are opiates and alcoholic stimulants.

Gelsemium, like aconite and veratrum viride, is a powerful arterial sedative, lowering the heart's action, relieving congestion, and unlocking the secretions. It is particularly applicable to inflammatory disorders attended with neuralgic pains, valvular disease of the heart, and the rheumatic or gouty diathesis. It may be administered in the form of fluid extract, in doses of five to ten drops, or that of a saturated tincture, in similar quantities, repeated every three, five, or eight hours, according to the nature and urgency of the case, its effects being carefully watched.

Of *digitalis* I have not been led to form a very favorable estimate as a depressant or sedative. I was formerly in the habit of employing it a great deal in various forms and combinations, as well as in various forms and stages of inflammatory disease, and yet it would be difficult for me to recall a solitary case in which I derived any appreciable benefit from it. I have, therefore, of late years, altogether abandoned its use.

6. *Diaphoretics.*—Diaphoretics, in their mode of action, bear the same relation to the skin as cathartics bear to the bowels. They constitute, therefore, a highly important class of remedies in inflammation, from the faculty which they possess of restoring and modifying the cutaneous perspiration, the suppression of which is so frequent a source of disease.

As the quantity of perspiration daily thrown off by the skin, in the normal state, varies from twenty to thirty ounces, the retention of such an amount of material in the system must necessarily exert a most prejudicial influence upon the suffering organ. The importance of a critical sweat, as it was called by the ancient physicians, in arresting disease, has long been familiar to the practitioner, and the employment of diaphoretics is only an attempt to imitate nature's efforts, in removing a cause of morbid action, or restoring a secretion which has been suppressed by the changes which that action has induced in the general system. As in the case of purgatives, depletion should always precede the employment of the remedy, so should it in the case of diaphoretics, a relaxed condition of the body always powerfully predisposing to a favorable action of the medicine.

Although the class of diaphoretics is very large, there are only a few articles that are really at all reliable, or that are much employed by the experienced practitioner. These are tartar emetic, ipecacuanha, and Dover's powder, aided, if necessary, by tepid drinks, and sponging of the surface with tepid water. The spirit of Mindererus, a solution of acetate of ammonium, in combination with a small quantity of spirit of nitrous ether, forms a mild diaphoretic, often advantageously used in low states of the system. The efficacy of antimony, which deserves the highest rank in this class of remedies, will be greatly increased if it be given in union with morphia, the two articles thus counteracting the bad effects which they are so liable to produce if administered singly, at the same time that they subdue the heart's action, relax the skin, relieve pain, and induce sleep. The best form of exhibition is a watery solution, each dose containing from the eighth to the tenth of a grain of antimony, with from one-fourth to one-eighth of a grain of morphia, repeated every two, three, or four hours. Ipecacuanha is adapted chiefly to children and old persons, and to the latter stages of the disease, and may be given alone, or, what is preferable, with some of the preparations of opium. The ordinary dose of Dover's powder, for an adult, is ten grains, to which, especially if there be severe pain or great restlessness, I generally add the sixth of a grain of morphia, repeated every eight, ten, or twelve hours. The action of these remedies should always be aided by tepid drinks, and, if there be much dryness of the surface, by frequent sponging of the body with tepid water. During very hot weather, and in high states of inflammation, cool ablutions are often more efficient, as well as more grateful, than warm.

When a speedy and powerful diaphoretic effect is desired, as, for instance, in a severe attack of gout, rheumatism, or acute nephritis, in a young robust person, nothing answers so well as jaborandi, given either in the form of the fluid extract, or that of the alkaloid known as pilocarpin, the dose of the former being one drachm, and of the latter half a grain. Copious perspiration, accompanied by a free flow of saliva and an excess of urea, generally promptly ensues. The only objection to the remedy is its liability to nauseate and to cause excessive prostration, on which account it should be administered with great caution.

When nausea exists along with a very arid condition of the skin, excessive thirst, and inordinate restlessness, the very best diaphoretic is lemon juice, in tablespoonful doses, saturated with bicarbonate of potassium, the salt being added slowly and gradually until all effervescence ceases. The addition of a little syrup of orange-peel renders the mixture more palatable. If an arterial sedative be required, the object may be readily attained by combining with each dose a minute quantity of tartar emetic, as the tenth or twelfth of a grain, or a few drops of tincture of aconite.

Bathing is not often employed in the treatment of acute inflammation, on account, chiefly, of the inconvenience and fatigue attending the operation. In the chronic form of the disease, however, it is frequently a remedy of great value, especially in affections of the skin, joints, and abdominal viscera. The water, which may be simple or medicated, is used at various degrees of temperature, the tepid bath ranging from 85° to 92°, the warm from 92° to 96°, and the hot from 96° to 112° Fahr. A very excellent and convenient mode of conveying moist and heated air to the patient's body, as he lies in bed, consists in attaching one end of a tin tube, from three to four feet in length, to a teakettle filled with hot water, the other end being placed under the bedclothes. Copious perspiration usually promptly follows the application, which may be maintained for any desirable period. The foot-bath is occasionally used with advantage, but to derive full benefit from it the patient should be well covered up in bed, his feet hanging in the water placed in a suitable vessel upon a chair, the immersion being continued from thirty to sixty minutes, and aided by hot drinks. The hip-bath is employed chiefly in affections of the genito-urinary organs.

7. *Diuretics.*—Diuretics are medicines intended to restore and modify the renal secretion, which is invariably more or less changed in all acute inflammatory affections. Their employment should, as a general principle, be preceded by depletory measures, and they should never be given in inflammation of the kidneys and bladder. Their administration is usually accompanied by mucilaginous drinks, but these are not at all necessary to their beneficial effects, ordinary fluids answering quite as well. They may be conveniently arranged under three distinct heads, the first including those articles which, when received into the system, depurate the blood, and increase the quantity of solid matter of the urine, as the nitrate, acetate, and bitartrate of potassium. The second class comprises colchicum, squills, and other vegetable diuretics, which carry off the watery portions of the blood; while the third consists principally of copaiba and cubebs, which not only augment the renal secretion, but exert a peculiar influence upon the mucous membrane of the bladder and urethra, as is evinced in cystitis and gonorrhœa. Of these various articles, the most important, in the treatment of acute inflammation, are nitrate of potassium and colchicum. The former may be given in doses of from fifteen to thirty grains every three, four, five, or six hours, in a large quantity of water. Instead of the salt, spirit of nitrous ether is often employed, especially when a gentle and slightly stimulating diuretic is needed. Colchicum is generally given in the form of the vinous tincture of the seed, in doses varying from ten to fifty drops, several times in the day and night. My practice usually is to employ one drachm along with one-third to one-half a grain of sulphate of morphia every evening at bedtime. In this way the medicine produces a much more decided impression upon the system, as well as upon the renal secretion, increasing its quantity, and freeing it of lithic acid, and probably, also, of other nitrogenized elements. Moreover, it usually acts upon the bowels, bringing away thin watery evacuations, especially when employed by itself; and in large quantities it often vomits. One full dose, administered in this manner at bedtime, is far superior to three or four small ones, which often only fret and irritate the kidneys and bowels, placing them in a condition ill adapted to correct morbid action.

The alkalies, used as diuretics, combine with the acids in the system, and generally pass off as salts. Their value, as remedial agents, consists not only in neutralizing these products, always so injurious when in excess, but in retarding the formation of blood, in dissolving the fibrin, and in diminishing the quantity of albumen.

8. *Anodynes.*—There is no class of remedies which requires a greater amount of nice judgment and correct discrimination, in respect to their selection, mode of combination, and time of administration, than anodynes. The subject, therefore, is one that should be carefully studied by every one desirous of acquiring accurate views of their practical application in the treatment of inflammatory affections. My conviction is that these remedies are not used sufficiently freely, and that they are capable, when properly exhibited, of affording immense benefit, not only in allaying pain and inducing sleep, but frequently also in controlling morbid action, and, consequently, in abridging its course and preventing its ravages.

The same rules, as it respects the premising of depletory measures, are applicable to anodynes as to cathartics. Thus, first, whenever there is plethora, fecal distension, or disorder of the secretions, their correction should, if possible, precede the exhibition of the opiate. Sometimes a full dose of morphia is made to succeed a large bleeding, or an active purgative, the medicine then exercising a decidedly sedative and soothing influence. Administered before the system has been properly relaxed, the medicine rarely fails to increase the vascular action, to arrest the secretions, to produce headache, to prevent sleep, and to augment thirst and restlessness.

Secondly, the medicine should always be exhibited in full doses, as it will thus make a much stronger, as well as a much more soothing, impression than when it is taken in small, and frequently repeated doses. With the precautions pointed out, an adult will bear, when the symptoms are at all urgent, from two to four grains of opium, or its equivalent of morphia, every twelve, eighteen, or twenty-four hours. The effects of the remedy must be steadily watched, especially if the patient is a child, or if there is any undue cerebral excitement. Should the pulse, under its influence, increase in fullness and vigor, the skin become more hot and dry, or the vigilance and restlessness augment, repetition is temporarily suspended, until, by further depletion, the system is placed in a more favorable condition for its reception.

Thirdly, the best period for the exhibition of the medicine, when there is no immedi-

ate necessity for its use, is towards bedtime, the patient being thus more likely to obtain quiet and refreshing sleep after the removal of light and other external stimulants.

Fourthly, when there is excessive pain along with great dryness of surface, and the depletion has already been carried to a sufficient extent, the anodyne should be combined with a diaphoretic, as ipecacuanha, or, what is better, tartar emetic, or, instead of this, a full dose of Dover's powder is given.

Anodynes are particularly beneficial in inflammation attended with violent pain, which, by its persistence, might rapidly wear out the powers of life. Their value cannot be too highly appreciated in the phlegmasias of the skin and connective tissue, the joints, the subdiaphragmatic viscera, the eye, ear, pleura, heart, and respiratory organs. Within the last twenty years enormous doses of opium have been given in peritonitis with the most happy results, and the same mode of treatment might, there is reason to believe, be advantageously extended to inflammation of many of the other parts of the body. The importance of absolute rest to the affected organ is universally conceded, and is daily witnessed in the management of external inflammation. Instinct alone is often sufficient to secure it, but when this fails, the surgeon endeavors to procure it by means of various mechanical appliances. In the internal phlegmasias no such means are applicable, but here the object may readily be obtained by opiates, given in full and sustained doses to control the movements of the suffering structures. In gastritis nothing so promptly and effectually quiets the muscular fibres of the stomach as a suitable quantity of morphia; and the same treatment has long been successfully employed in dysentery, or inflammation of the lower bowel. In cystitis the most effectual remedy for allaying the excessive spasm and the incessant desire to urinate, is a full anodyne. In pleuritis and pneumonitis, how is it possible to afford rest to the lungs and respiratory muscles, except by the same means? The more quietly the parts are kept while laboring under disease, the sooner, other things being equal, will the patient recover from its effects, and the less pain will he be compelled to endure from the constant and rude contact of the affected surfaces upon each other. Even in inflammation of the brain and its meninges, after proper depletion has been practised, anodynes are frequently indispensable, not only to allay pain and induce sleep, but to control the morbid action. And how do they do this? Simply, in the first place, by subduing the action of the heart, and thus preventing it from sending to the brain its accustomed quantity of blood; and, secondly, by making a direct impression upon the brain itself, thereby, in some degree, controlling its movements, so injurious both to its own substance and to its coverings, when thus affected. Anodynes, in most of these cases, as well as in many others, literally constitute nature's splint.

The best anodynes are opium and its different preparations, as the salts of morphia, codeia, laudanum, and black drop. These may be given either by the mouth or by the rectum, double the quantity being usually required to produce the same effect in the latter as in the former case. When a person cannot bear opium in any form, a substitute should be sought in lupuline, hyoscyamus, aconite, Indian hemp, and kindred articles; or, in what I have generally found to answer very well, a union of morphia, tartar emetic, and bicarbonate of potassium, neutralized by lemon-juice.

Many persons bear codeia better than any other form of opium, as it relieves pain and tranquillizes the system, without inducing any cerebral disturbance. The ordinary dose is from half a grain to a grain. Battley's sedative, a watery infusion of opium, sometimes agrees better with the system than any other preparation of opium, the average dose for an adult being about twenty drops.

Hypodermic injections of morphia are much employed, and very justly so, in sleepless and painful conditions of the system, whether the result of inflammation or of other causes, the relief thus obtained being almost instantaneous, without any of the unpleasant effects of morphia when administered by the mouth or rectum. The quantity of the salt should not exceed, at first, on an average, one-fourth of a grain, from which it may be gradually increased to one-half, three-fourths, or even an entire grain, according to the exigencies of the case, the effects of the remedy being always carefully watched.

Finally, there is a condition of the system in which a patient is "too weak to sleep," and in which anodynes, as usually exhibited, instead of being beneficial, are decidedly injurious. This species of exhaustion is often witnessed in inflammation consequent upon severe shock and loss of blood, and is generally most readily controlled by chloral and bromide of potassium, tonics, stimulants, and nutrients, taken as freely as the tolerance of the stomach will admit. As soon as the strength has thus been recruited, recourse may be had to opiates, and now with a prospect of marked advantage, especially if they be

conjoined with some mild diaphoretic, as Dover's powder, spirit of Mindererus, or morphia and acetate of ammonium.

Bromide of potassium is a most valuable remedy in all low forms of inflammation, attended with loss of sleep, unusual nervous excitement, and irritability of the stomach. It should be given in full doses, as from twenty to thirty grains, every two hours, or even more frequently, until the object is attained, when it may be repeated at longer intervals. In the excitement consequent upon delirium tremens there is no article which, according to my experience, produces such prompt and decided relief as bromide of potassium in large and sustained doses.

As a speedy, trustworthy soporific, there is no medicine at all comparable to hydrate of chloral. Its great advantage is that it rapidly induces sleep, without being followed by any of the disagreeable effects of opium and its different preparations. The only objection to its use is its unpleasant taste, but this is generally easily counteracted by giving it in union with syrup of orange-peel. The full dose is thirty grains, repeated every few hours, according to the exigencies of the case. One-third of that quantity often produces a most decidedly hypnotic effect in low states of the system. When the object is to subdue pain, as well as to promote sleep, the chloral may generally be advantageously combined with morphia, from ten to fifteen grains of the former to one-sixth of a grain of the latter constituting a suitable dose in ordinary cases.

Sponging the surface of the body and limbs with tepid, cool, or cold water, as may be most agreeable to the feelings of the patient, often exercises a most salutary influence in cases of insomnia, especially when there is inordinate heat of the skin, tranquillizing the system, promoting perspiration, and inducing healthful and refreshing sleep, when everything else fails.

9. *Tonics.*—There are few cases of acute inflammation, of any severity, in which tonics do not, sooner or later, prove indispensable elements of treatment. Very frequently, indeed, their exhibition is required at the very outset of the disease. This is especially true of persons whose constitution has been exhausted by severe shock, loss of blood, habitual intemperance, or the depressing effects of malaria, contagion, or blood-poisoning. In all these cases, and others of a similar character, depletory measures are either entirely inadmissible, or applicable only in a very limited degree. The general perturbation, in fact, is often feigned rather than real, and it not unfrequently vanishes in a few hours under the influence of a mild purgative or an anodyne diaphoretic. Active remedies would only expedite the downward tendency by still further exhausting the powers of life. In all the more violent inflammatory assaults, there is a period when tonics are indispensably necessary. The system, enfeebled by the conjoint effects of disease and depletory measures, must be upheld at all hazard. Tonics, stimulants, and nutritious food and drink now come in play, and must be freely administered. The empty bloodvessels and the impoverished tissues must be replenished and improved by all suitable means.

Among the more important tonics are the different preparations of bark, especially quinine, cinchonia, and Huxham's tincture, the various forms of iron, as the sulphate and the tincture of the chloride, the bitter infusions, the mineral acids, as the nitric, phosphoric, and sulphuric, alcohol and wine. Much judgment is required in the use of these articles, both as it regards their doses and the time and mode of their administration. They may be given either separately, or in various forms of combination, according to the exigencies of the case, or the object which they are intended to fulfil. When there is flatulence or nausea, some corrigent, as ginger or capsicum, may often be advantageously added to the prescription. Of all these articles, by far the most valuable, as a general rule, are quinine and the tincture of the chloride of iron, with brandy, whiskey, or wine. The dose of the former ranges, on an average, from two to three grains every three or four hours; of the latter, from fifteen to twenty drops. The efficacy of these two medicines is often greatly enhanced by giving them in union with each other. Of all the tonics and stimulants, however, the best and most trustworthy, unquestionably, is alcohol, which may frequently be taken in enormous quantities in all low states of the system, however induced. The choice of the form may generally, very properly, be left to the taste of the patient. A good plan is to vary the prescription occasionally, as one article becomes disagreeable another taking its place. The effect must of course be carefully watched. Wine is frequently preferred to brandy or whiskey. Port, sherry, and Madeira are the most eligible articles of this class. Champagne may be used when there is nausea, flatulence, or indigestion.

Carbonate of ammonium, formerly so much vaunted in all low, asthenic states of the

system, is now seldom employed as a stimulant, experience having shown that it possesses hardly any such property, even when taken in very large quantity. It may, however, often be advantageously exhibited, after the violence of the disease has disappeared, for the purpose of promoting the absorption and elimination of inflammatory deposits, during the progress of their fatty degeneration. The dose should be large, as from ten to fifteen grains, freely diluted with water, and repeated every three, four, or five hours.

10. *Antiperiodics.*—Antiperiodical remedies very justly occupy a high rank in the treatment of inflammation; for there are few cases of the idiopathic form of the disease in which malaria is not present, in some stage or other, or in which, if it does not act as a predisposing cause, it does not impress its peculiar livery upon the system. Malaria has long been known, especially in our Western and Southern States, to play a most important part in the causation and maintenance of certain forms of pneumonia, in the treatment of which the preparations of bark, in large doses, constitute an essential element, which does more in preserving the life of the patient than any other therapeutic agent. In the treatment of erysipelas, boils, carbuncles, and kindred affections, antiperiodics are generally of immense benefit, and after all serious operations and accidents they are of inestimable value in improving the patient's strength, and promoting the action of other remedies. These remarks are particularly applicable to quinine, the most trustworthy of all antiperiodic medicines. Administered in regularly sustained doses, from two to five grains every three, four, or six hours, it opens all the emunctories, relieves pain and fever, imparts tone to the nervous system, increases the appetite, and lessens the frequency of the heart's action. After severe shock and loss of blood, there is no article of the materia medica which renders so much service in preventing pyemia, erysipelas, and other low forms of disease, as quinine. Other antiperiodics are sometimes used, but they are chiefly adapted to the chronic form of disease, in which they are frequently given with marked success.

11. *Combination of Remedies.*—There are few acute surgical diseases or severe accidents in which a combination of several of the remedies now described may not be advantageously employed. In nearly every case of the kind the patient will be found to be oppressed with fever, thirst, pain, and restlessness; or, in other words, to labor under incited action of the heart and arteries, attended with diminished, if not suspended, secretion, and all the evils consequent upon such a state of the system. To meet the indications of treatment, under such circumstances, there is no prescription which, according to my experience, is capable of conferring greater benefit than what may be termed the saline and antimonial mixture, consisting of the following ingredients:—

> ℞. Antimonii et potassii tart. gr. ijss.
>   Magnesii sulph. ℥ij.
>   Morphiæ sulph. gr. j¼.
>   Acid. sulph. aromat. ℨss.
>   Tinc. veratr. virid. ℨjss.
>   Syr. zingiber. ℥ij.
>   Aquæ destil. ℥x.
> M.

Of this combination the average dose is half an ounce, repeated every two, three, four, or six hours, according to the circumstances of the case. If emesis or distressing nausea ensue, the dose must be diminished. Properly administered, it rarely fails rapidly to subdue vascular excitement, to cause copious perspiration, to allay pain, thirst, and restlessness, to act gently on the bowels, and to induce sleep and general tranquillity. Instead of the veratrum, aconite or gelsemium may be used in similar quantities. Colchicum may be added when there is a rheumatic or gouty state of the system, quinine when there is a tendency to periodicity, and copaiba when there is renal or cystic trouble. The quantity of morphia may be increased when there is much pain.

12. *Antiphlogistic Regimen.*—Under this head are comprised the patient's diet, the ventilation of his apartment, and various other attentions required during his confinement. The subject is one which rarely receives the consideration its importance demands.

Few persons, fortunately, have any appetite during the height of an inflammatory attack, and hence the surgeon seldom experiences any difficulty in regard to the regulation of the diet. The stomach, oppressed with nausea, or a sense of uneasiness, either

loathes food, or rejects it almost the moment it is swallowed. It is well it should be so; for any ingesta, however mild, taken at this period, would only become a source of further trouble, by increasing the morbid action, perhaps already progressing at a furious rate. When the appetite remains, it must be repressed, steadily and courageously, until all danger of over-excitement from its indulgence has been safely passed. The mildest and least nutritious articles only are admissible in the earlier stages of the disease, such as panada, gruel, arrowroot, sago, and tapioca. Not even the lightest animal broth is permissible, unless there is decided tendency to prostration, or an irritable state of the system, clearly dependent upon the want of proper nourishment, as occasionally happens in persons of a nervous, irritable temperament, or who are habitually huge feeders. The drinks should be cooling, consisting of iced water, gum-water, linseed tea, or barley-water, either simple, or slightly acidulated with lemon-juice, tamarinds, or any of the subacid fruits; care being taken that, while they are used freely, they are employed in such quantity as not to produce gastric and intestinal oppression.

As soon as the violence of the disease has abated, or the vital force begins to flag, a more nourishing diet must be employed; and the articles generally best calculated to meet this contingency are Liebig's beef essence, beef-tea, the different kinds of animal broths, vegetable soups, eggs, broma, porridge, and corn starch, along with milk, wine, wine whey, and milk punch, given at suitable intervals, and in sufficient quantity to supply the waste of tissue, blood, and nervous fluid. The return to solid food should be very gradual, lest it rekindle morbid action. The starving cells must be fed slowly, not rapidly. When gastric irritability exists, along with excessive flatulence, nothing generally affords such prompt and effectual relief as small quantities of champagne administered in ice. Acidity, or heart-burn, is relieved with subnitrate of bismuth, or bicarbonate of sodium, either alone or combined with ginger. Water ices and ice cream are nearly always admissible in every stage of inflammation.

Koumiss, or milk prepared with yeast and sugar, closely bottled, and kept in a cool place, is an excellent article of diet, highly nutritious, grateful to the stomach, and well suited to dyspeptics in low states of the system. It should be made fresh every day, and may be taken at pleasure, either alone or combined with wine, whiskey, maltine, or infusion of hops, according to the taste or wishes of the patient.

Concentrated essence of beef, made of four pounds of meat yielding a pint of soup without water, is a popular article of diet with English practitioners, in all low states of the system, and may be taken more or less frequently in quantities of one to two ounces, according to the patient's wishes and the tolerance of the stomach. Hot toddy is often very grateful, especially when the patient is cold or chilly; and its efficacy may occasionally be much increased by the addition of an egg and a little spice.

When food and drink cannot be taken by the mouth, they should be administered by the rectum, previously washed out with an enema of warm water, or if there be no contraindications, the bowels should be evacuated by a gentle laxative. In this manner, life may often be prolonged for weeks, and even months. The articles most worthy of reliance as sustenance are defibrinated blood, beef essence, Liebig's extract of meat, animal broths, milk, cream, and raw egg, either alone or combined with brandy or whiskey, from two to five ounces being slowly injected, with a well-warmed syringe, every three, four, or six hours. If the bowel is irritable with a tendency to reject the fluid, a little morphia, laudanum, or acetate of opium, may advantageously be added. Thirst is assuaged by gargling with cold water, by freely sponging the body, and by injecting, occasionally, if necessary, water into the rectum. When the vital powers are greatly exhausted, and all sources of nourishment are unavailing, life may occasionally be prolonged, if not actually saved, by the transfusion of blood, or even of milk. The effort, at all events, is worthy of trial under similar circumstances. The inhalation of oxygen or of the vapor of alcohol is sometimes serviceable.

The promptings of nature should not be disregarded during the progress of recovery; their tendencies are generally wholesome, and they should, therefore, be gratified to at least a reasonable extent, unless there are well-marked contraindications. Acid drinks and food are particularly apt to be craved, and a moderate use of them is highly beneficial, not only in whetting the appetite, but in promoting digestion, by supplying the exhausted stomach with substances tending to atone for the want of a due amount of gastric juice, so essential to healthy chymification. Improper indulgence is, of course, avoided, and care is also taken that the articles are of such a character as to prevent the occurrence of acidity and flatulence.

Rest of mind and body must be carefully observed. The importance of this is so self-

evident that it need not be enforced by any labored argument. Whatever has a tendency to excite the heart's action must necessarily increase the momentum of the circulation, and, through it, the inflammation. In all severe attacks the patient must keep his bed, from which he must not rise even to answer nature's calls; light and noise are carefully excluded from his apartment, especially in inflammation of the eye, brain, and ear; and no persons should be permitted to be about him, except his immediate attendants. Many a patient is killed by the kindness of his friends and relatives. Sexual intercourse must be scrupulously avoided during convalescence. Any excitement of this kind is not only exhausting, but has occasionally proved fatal.

A frequent change of posture is indispensable to the comfort and well-being of a sick person, and should be effected with the greatest possible caution, especially when there is uncommon debility. Violent pain, loss of sleep, excessive constitutional irritation, and dreadful bedsores are sure to follow, in all low states of the system, when this precaution is neglected. When the patient is exhausted from shock or hemorrhage, as after a severe injury or a capital operation, care must be taken not to raise his head too suddenly, or to prop him up with pillows, as he will need all the blood that the enfeebled heart is able to propel to the brain. The bed and body clothes should be kept perfectly smooth, otherwise the wrinkles will be sure to become a source of annoyance, if not positive suffering. The mattress should be soft and elastic, and the sheet pinned fast to the edge of the bed. In case of carious disease or injury, a water-bed will be the most comfortable. Frequent change of posture is especially demanded in paralytic patients, on account of their liability to fatal attacks of bronchitis and pneumonia, from the habitual stasis of blood in the posterior parts of the lungs. Bedsores are also exceedingly prone to occur in this class of sufferers. When the patient is able to sit up in bed, he will experience great comfort from the use of a bed-rest.

The temperature of the patient's room should be regulated, not by his feelings, which are often deceptive, but by the thermometer. On an average, it should not exceed 65°, but in some cases it may range as high as 78°, and in others as low as 60°. The apartment should be frequently ventilated. When it is recollected how soon the air becomes vitiated during sickness, and how necessary a due supply of oxygen is to the proper maintenance of the health, importance of attention to this subject will not be doubted. Cleanliness of the body and of the bedclothes, is another subject of vital moment in the treatment of inflammation, and one upon which few practitioners bestow sufficient consideration. To medicate the inside of a patient, while the outside is neglected, is one of those singular inconsistencies which are daily witnessed in the sick-chamber. I would not insist upon too frequent ablutions and changes of this kind, but they should certainly, in ordinary cases, be effected at least once in the twenty-four hours; care being taken to avoid unnecessary exposure and fatigue during their performance. Even the arrangement of the furniture is worthy of attention, on the principle that an agreeable impression, of whatever kind, is more conducive to comfort and recovery than one of an opposite character.

In all cases of a severe character the thermometer should be frequently used to ascertain the temperature of the body. An elevation of heat is a common occurrence in all inflammatory as well as typhoid states of the system, and, when sudden, great, or persistent, is of evil omen. The heart, lungs, and brain cannot hold out long under the effects of a temperature of 105° or 106°, especially if still advancing, and preceded by chilly sensations, rigors, or horripilations. For meeting such a condition of the system the surface should be freely sponged with tepid water, or, if the patient be strong and robust, in the heat of summer with cool water, with the addition, in such case, of a little alcohol, vinegar, common salt, or chlorinated soda.

II. LOCAL TREATMENT.—The local remedies of inflammation consist of rest and elevation of the affected part, the abstraction of blood, cold and warm applications, compression, destructives, and counter-irritation.

1. *Rest and Position.*—Without rest, steady and persistent, of the affected part, little progress can be made toward the cure of inflammation. The practitioner who neglects attention to this important circumstance, performs only half his duty. The patient, ignorant of its advantages, often continues to exercise the affected organ long after it has become unfitted for the discharge of its functions, much to his present discomfort and ultimate detriment. A simple conjunctivitis, that might be cured in a few hours, is often for the want of a little rest of the eye, urged into a violent and protracted ophthalmia,

perhaps, at length, eventuating in a total loss of vision. An inflamed joint is frequently for the same reason, rendered permanently stiff and useless. Hence, rest is universally regarded as one of the most essential elements of the local treatment of inflammation. In general, it is easily procured, simply by the patient's own efforts; but when this is impracticable, it must be insured by appropriate splints, and other means, applied so as not to interfere with the other treatment. In inflammation of some of the internal organs, as the heart, stomach, peritoneum, bowels, and urinary bladder, the object is attained by the liberal use of anodynes, which, by temporarily paralyzing the muscular fibres of the affected structures, effectually prevent peristaltic motion, and thus place them in a better condition for speedy recovery. But there is a period when rest must not be enforced too rigidly, for, if continued too long, it may be productive of much harm. Its great utility is in the earlier stages of inflammation, when morbid action is gravescent, and for some time after it has reached its culminating point. As soon as recedence has fairly begun, motion, gently and cautiously conducted, is often of great utility.

Not only should the part be kept at rest, but it should also be maintained in an elevated position, the success of the treatment being thereby greatly enhanced. The importance of attention to this point is well exemplified in many familiar diseases. The patient himself is often conscious of it, and, therefore, resorts to it, as it were, instinctively. Who that has ever had an attack of whitlow does not remember the great relief which he experienced from carrying his hand in an elevated position? The influence of position is nowhere more strikingly evinced than in odontalgia. During the day, the patient, while attending to business, is, perhaps, hardly conscious of suffering, but, at night, the moment his head touches the pillow the tooth begins to ache and throb, compelling him to get up and pace his room. In orchitis, the beneficial effects of our remedies are always greatly aided by elevation conjoined with rest of the affected organ. It is quite easy to understand why this should be so. In inflammation, the vessels carry an extraordinary quantity of blood, which is still further increased when the suffering structures are placed in a dependent position, because the flow, not being opposed by gravity, has then free scope, thus crowding the already distended capillaries to the very utmost, and proportionately aggravating the morbid action.

Finally, the inflamed part should also be maintained in as easy a position as possible, mere rest and elevation not sufficing to insure comfort. All restraint must be taken off; all muscular contraction counteracted. Thus, in inflammation of the knee-joint, the limb should recline upon its outer surface, a pillow being placed in the ham, this being the best position for preventing tension. In synovitis of the elbow-joint, the forearm is bent at a right angle with the arm; and in hip-joint disease, the thigh is slightly flexed upon the pelvis, and turned towards the sound one.

2. *Local Bleeding.*—Blood may be abstracted locally by scarification, incision, puncture, leeching, and cupping, each being more or less serviceable, in its own way, in particular cases and under particular circumstances.

The manner in which topical bleeding affords relief is sufficiently evident in some of these forms of depletion, but not very apparent in others. Thus, in scarifying, incising, or puncturing a part, the blood is taken directly from the engorged vessels, which are thus drained of their altered and vitiated contents. If the operation be carried to any considerable extent, as it often may be, especially in the former of these procedures, we may, at the same time, make a powerful impression upon the general system, nearly as rapidly and quite as effectually as when blood is drawn from a vein at the bend of the arm, although, in general, such an effect is neither aimed at nor desired. A similar influence is exerted by leeching or cupping, provided the operation is performed upon the inflamed surface, or in its immediate vicinity. Frequently, however, it is performed at a remote point, and then its mode of action is less intelligible. Thus, in inflammation of the brain, it is difficult to determine how leeches and cups, applied to the nape of the neck, temples, or back of the ear, afford relief to the affected organ. It is certainly not possible, in such a case, to make any direct impression upon the seat of the disease; whatever influence is exerted must be exerted through the general system. This is a self-evident proposition. The vessels of the neck and scalp have no direct communication with the vessels of the brain; hence, in leeching and cupping these parts, we can no more drain the cerebral capillaries than we can drain those of the hand, chest, or any other distant part. It may be assumed, then, that, when topical bleeding is practised by either of the latter methods, its beneficial effects are due, not to any direct drainage of the suffering structures, but indirectly to the depressing influence which it exerts upon

the heart and nervous system, and, through them, upon the morbid action, diminishing the momentum of the circulation, and, consequently, the flow of blood in the capillaries at the seat of inflammation.

Topical bleeding, to be effective, should, as a rule, be preceded by some form or other of general depletion. When the force of the morbid action has thus been broken, the rest of the malady is often easily dealt with by the local abstraction of blood. It is only when the disease is very mild, or unaccompanied by marked constitutional disorder, that this rule should be disregarded. Under such circumstances, the treatment may occasionally be very properly commenced with the application of leeches, cups, or scarification, followed or not, as the exigencies of the particular case may seem to require, by other measures. The manner of abstracting blood topically will be pointed out in the chapter on Minor Surgery.

3. *Cutting off the Supply of Blood.*—Cutting off the current of the circulation from the inflamed structures by ligating the main artery of a limb, is a procedure which has occasionally been employed with advantage, although it is not likely, from its severity, ever to come into general use. The credit of suggesting it is due to Dr. Henry U. Onderdonk, of New York, who practised it successfully in 1813, in a case of wound of the knee-joint. A similar operation was performed in 1824, by Dr. David L. Rogers, upon a man thirty years of age, with equally favorable results. These surgeons were led to believe, from the results of these examples, that the operation, if performed sufficiently early, would often supersede the necessity of amputation, especially in compound fractures and dislocations, as well as in the more violent forms of spontaneous inflammation. The object is to starve the diseased structures by diminishing the activity of the circulation. In 1866, Professor Henry F. Campbell, of Georgia, recalled the attention of the profession to this mode of treatment, in an article in the Southern Journal of the Medical Sciences, in which he adduced a number of cases, chiefly of gunshot injuries of the bones and joints, in which it appeared to have yielded the most gratifying results, the pain, swelling, and tension being almost immediately relieved, and the character of the discharges greatly improved. In five cases in the practice of Dr. D. F. Wright, during the War of the Rebellion, two of the upper and three of the lower extremity, the beneficial effects seem to have been equally striking. In 1867, Mr. C. F. Maunder, of London, successfully tied the femoral artery for the cure of acute inflammation of the leg and thigh, consequent upon a wound of the knee-joint. The chief objection to the proceeding is the grave nature of the operation, which, by cutting off suddenly so great a quantity of blood, might be followed by gangrene of the distal portion of the limb, the very effect which the treatment is designed to prevent. It may readily be supposed that cases might arise which might justify such an undertaking, and yet it is difficult to point them out in a satisfactory manner. How far digital compression, recommended by Professor Vanzetti, of Padua, as a substitute for ligation in such cases, may answer the purpose, remains to be determined. The practice is very favorably spoken of, not only by its originator, but by Neudörfer, Demme, and other military authorities.

4. *Cold and Warm Applications.*—These remedies, which are more particularly adapted to external inflammations, comprise a great number of articles in the form of water dressings and cataplasms, with the character of which every practitioner should be perfectly familiar. Both classes of remedies may be simple or medicated, according to the tolerance of the part and system, and the nature of the morbid action.

(1.) *Cold water* has been employed in the treatment of inflammation from time immemorial; and it is not difficult to conceive how it operates in subduing morbid action. The effect of cold is evidently that of a sedative, lowering the temperature of the part, and causing contraction of the vessels, thereby relieving pain, swelling, and tension. It is particularly applicable to inflammation in its incipient and gravescent stages, while there are, as yet, little effusion, and no serious structural lesion. When the action has reached its acme, threatened suppuration, or, what is worse, tending to gangrene, it must be promptly discontinued. Besides, it is well known, cold, when intense or protracted, may of itself cause gangrene. Young and robust persons usually tolerate such applications much better than the aged or feeble; they are also better borne in summer than in winter. As it is impossible always to predetermine their effects, their action should be carefully watched, in order that, if they become a source of annoyance, they may either be entirely dispensed with, or employed in a modified form. After suppuration has ceased cold

may often again be advantageously employed to relieve vascular engorgement, and to promote the absorption of inflammatory deposits.

The water may be rendered anodyne, astringent, or antiseptic, according to circumstances, by the addition of opium, acetate of lead, or some of the chlorides. The best way to use it is to cover the affected part with a piece of old porous linen, and to direct upon it a constant flow of water in the form of irrigation, from a basin with a stopcock, slung to the top of the bedstead, the limb lying on an oil-cloth trough, from which the fluid is conducted into another vessel standing near the bed. Or the part may be covered with a wide, thin piece of sponge, spongiopiline, or common linen, over which is placed a bladder partially filled with pounded ice. Or the water may be conveyed from the basin by means of a candle wick to a layer of lint upon the inflamed surface, the wick acting on the principle of a syphon. Finally, when ice cannot be obtained, the water may be rendered cold by means of alcohol, in the proportion of one to six parts of the fluid ; by pyroligneous acid and alcohol ; or, by hydrochlorate of ammonium and nitrate of potassium. In whatever manner the fluid be employed, the surface to which it is applied should be constantly exposed to the air, to favor evaporation.

Dry cold is not often used in the treatment of inflammation, although there are cases where it is preferable to cold combined with moisture, as when there is high morbid action in a part greatly debilitated, and rapidly tending to gangrene. The best mode of applying it is in the form of pounded ice, confined in a thin vulcanized India-rubber bag, carefully spread over the affected surface. If a bladder be used, the part should be protected with a thin piece of flannel, otherwise the ice may produce too depressing an influence. The application of pounded ice is particularly valuable in the treatment of acute inflammation of the joints, the result of gunshot and other injuries.

(2.) The use of *warm water* is also of great antiquity, having been employed by Hippocrates and other practitioners in gangrene and various cutaneous affections. It has, however, only been within the last thirty years that it has assumed anything like the rank to which its importance as an antiphlogistic remedy entitles it. I generally give a decided preference to warm water over cold, the impression made by it upon the part and system being usually more agreeable and soothing, while there is much less danger of metastasis, or of a sudden transfer of disease from the external to the internal parts of the body. It is particularly adapted to nervous, irritable individuals, who are easily chilled by cold applications, and to cases in which the inflammation has already made considerable progress, where there is much tension and swelling, or where suppuration is impending, or has already taken place. A good rule, both in regard to warm and cold applications, is to consult the feelings of the patient, using one or the other according to the tolerance of the part and system, or simply so long as they seem to be beneficial. When a change becomes requisite, care must be taken that it is not made too suddenly, or too rapidly, lest it produce harm. Thus, hot applications should be succeeded first by warm, then by tepid, afterwards by cool, and finally, if necessary, by cold, the transition being gradual and wary, not great and sudden, so as to shock the part and system, and thus cause undue reaction.

In the employment of cold water, the part is exposed ; in the use of warm, it is covered. The former does good by constringing the inflamed tissues, and opposing effusion ; the latter, by relaxing the tissues, and favoring effusion.

(3.) *Fomentations*, which may be considered as a species of local bathing, are often very beneficial in inflammation of the joints and some of the internal viscera, from their tendency to relieve pain, tension, and spasm. In cystitis, gastritis, enteritis, and peritonitis, as well as in wounds and other injuries of the pelvic and abdominal organs, their employment can rarely be entirely dispensed with. The most simple fomentation consists of a large, thick flannel cloth, wrung out of hot water, or water near the boiling point, by means of two sticks turned in opposite directions, and applied lightly to the part as hot as it can be borne. If a soothing, narcotic, or sedative influence is required, chamomile flowers, poppies, hops, or, what is much better, laudanum, or laudanum and alcohol, will be found to form valuable additions. In whatever manner they are used, they should be frequently renewed, care also being taken that there are two cloths, so that, while one is taken off, the other may immediately be applied, all danger of shock or undue reaction from exposure to the air being thus avoided.

(4.) *Stuping* is a variety of fomentation, particularly serviceable in affections of the eye, nose, ear, mouth, and throat. It is conducted with a piece of flannel, rolled into a ball, and contained in a small pitcher, which is held at a suitable distance from the affected surface, the cloth being wet as often as it becomes cool. The remedy may be medicated, if desired,

with laudanum, camphor, belladonna, hemlock, or any other article, anodyne, astringent, or sorbefacient.

When it is desirable to apply steam more directly, a funnel may be inverted over the hot fluid, and the tube held towards the affected surface at a suitable distance. Steam may be conveyed to any part of the patient's body, under the bedclothes, by means of a large rubber tube, attached to a small tin boiler, placed upon a table, over a lighted spirit lamp.

(5.) *Poultices*, or cataplasms, are an important class of remedies intended for external application in inflammation, wounds, ulcers, abscesses, and other affections. They are modifications of fomentations, and are made of various substances, either simple or medicated, according to the object intended to be fulfilled. They should not be heavy or bulky, and their consistence should be such as to enable them to accommodate themselves accurately to the surface to which they are applied, without being so tenacious as to adhere firmly to the skin, or so thin as to spread over the neighboring parts. Renewal should be effected as often as they become dry and cold, otherwise they will lose their good qualities and be converted into irritants. In general, it is sufficient to change them thrice a day; but in warm weather, or when there is much discharge, it may be necessary to reapply them every four, five, or six hours. Their temperature should be about the same as that of the body, that is, from 85° to 92° Fahr., and they should be placed directly upon the affected surface in a uniform layer from three to four lines in thickness, a piece of bobbinet, gauze, or thin netting being interposed to prevent adhesion and facilitate removal. For retaining the heat and moisture of a poultice the most suitable appliance is a piece of oiled silk, gutta-percha, or oiled paper.

The action of a poultice is usually limited to the skin, or to the skin and to the parts to which it is immediately applied; it is only when it is composed of very strong materials that its influence is more deeply felt. In using medicated cataplasms, it is necessary, especially in ulceration or abrasion of the skin, to remember that the active ingredient may be absorbed, and thus produce the same effects as when introduced directly into the stomach. Poultices differ very much in their mode of action; thus, some are altogether emollient, that is, they soften and relax the parts to which they are applied, at the same time that they promote exhalation and absorption; some are anodyne; some astringent; some antiseptic; some stimulant. The articles most commonly employed are bread, arrowroot, starch, elm bark, and linseed meal.

The *bread* poultice is made by pouring boiling water upon the crumbs of stale wheat bread, and stirring the mixture in a basin with the back of a spoon until it is of a thick, mush-like consistence. It is then spread upon a piece of folded cloth large enough to cover not only the affected surface, but also a portion of healthy skin. Milk may be used as a substitute for the water, but a poultice, thus prepared, must be more frequently changed, as it soon becomes sour and offensive, and possesses, moreover, no special advantages.

The *arrowroot* poultice is prepared in the same manner as when that article is used for food, only that it is rendered more consistent; the powder being mixed at first with cold and then with a sufficient quantity of boiling water to convert it into a thick, gelatinous paste. Such a poultice is admirably adapted to irritable sores, and deserves to be more frequently employed than it is.

The *starch* poultice is also a very soothing application, and is prepared in the same manner as the arrowroot poultice.

The *slippery-elm* poultice is made of the powdered bark of the slippery-elm, mixed with hot water. It is very light and demulcent, adapts itself readily to any irregularities of surface, and is particularly beneficial in burns. I esteem it as the best poultice that can be made.

The *linseed* poultice consists of ground linseed mixed with boiling water, and stirred until it is converted into a thick, cohesive mass, the vessel in which it is prepared being always well scalded previously. This poultice has the advantage of being very easily made, retaining its heat and moisture a long time, and of having a sufficiency of oil to prevent it from adhering to the surface to which it is applied.

Excellent emollient poultices may be prepared from apples, okra, carrots, turnips, or, indeed, of any of the more tender culinary roots, by boiling them, after having removed the skin, and mashing them into a soft pulp. They possess, however, no peculiar virtues, and are therefore seldom used.

A poultice may be variously medicated. Thus it may be rendered astringent by the admixture of acetate of lead, Goulard's extract, alum, or a decoction of oak bark; ano-

dyne, by laudanum, opium, morphia, poppy-heads, hops, or hemlock; stimulating, by chloride of sodium, vinegar, or port wine; absorbent, by iodine and other articles; disinfectant and deodorant, by Labarraque's solution, permanganate of potassium, thymol, or carbolic, and other acids.

The *fermenting* poultice, employed in foul, fetid, and painful ulcers, in hospital gangrene, and in mortification, used to be prepared by incorporating a pound of wheat flour with half that quantity of yeast, and exposing the mixture to a gentle heat until it swells. A better plan is, after the poultice is spread, to pour the yeast upon its surface. The port-wine poultice, which belongs to the same class as the fermenting, is made in a similar manner, except that it is not boiled.

The *charcoal* poultice, also a good antiseptic agent, although now rarely used, is prepared from recently burned charcoal, reduced to a very fine powder, and mixed with bread, oatmeal, elm bark, or ground flaxseed. The objection to this poultice is its liability to discolor the affected parts, thereby concealing their true condition. This may, however, be obviated, in great measure, by the interposition of very thin muslin.

A cataplasm may be rendered refrigerant by means of a freezing mixture, or a bladder partly filled with pounded ice and spread over its surface. Such an application, however, for reasons already stated, requires great care.

Poultices, even when quite mild, sometimes act as irritants, causing excoriation and tenderness, purulent vesicles, and even minute cutaneous abscesses. Such occurrences are most common in anemic systems and in persons of peculiar delicacy of skin. When any of these effects arise, the use of the cataplasm should be suspended, and the parts covered with warm or cold water, or dusted with oxide of zinc.

5. *Acetate of Lead, Goulard's Extract, and Chloride of Ammonium.*—The efficacy of water-dressings, and of cataplasms, is generally very materially increased by the addition of sugar of lead, Goulard's extract, or chloride of ammonium, either alone or in union with opium. That water alone is a most valuable antiphlogistic agent has been abundantly proved both in civil and military practice, but long experience, founded upon careful clinical observation, has satisfied me that it is far inferior to water medicated with these remedies, all of which possess more or less astringent and sedative, as well as sorbefacient, virtues, and are therefore well adapted to meet the indications that are presented in the treatment of inflammation, whether traumatic or idiopathic, slight or extensive, superficial or deep, recent or advanced. It would be difficult to say which of these agents deserves the preference. They may all be used warm or cold, and in various degrees of strength, according to the desired effect. Chloride of ammonium is especially adapted to those cases of inflammation in which there is extensive effusion of fibrin, or fibrin and blood, and its efficacy is generally materially increased by the addition of a small quantity of vinegar. A solution of the strength of one ounce to half a gallon of water is quite sufficient for ordinary purposes. When combined with an equal quantity of nitrate of potassium, it lowers the temperature of the part in a remarkable degree, without losing any of its sorbefacient properties. The only objection to it is its liability to cause slight pustulation, especially in persons of a very delicate skin; when this arises, its use must of course be temporarily suspended. Acetate of lead may be used in similar proportions, and is the article I generally prefer as a purely antiphlogistic agent. Goulard's extract is also a very valuable remedy on account of its astringent and sedative properties. The average quantity to a pint of water is about two drachms. When the morbid action is attended with severe pain, opium, laudanum, or morphia will be a most valuable addition, but these preparations must not be employed without great care when there is an abraded surface or an open sore, lest the medicine entering the system too freely should produce a poisonous effect. When opium is used in substance, it should be well powdered, and dissolved in boiling water to extract its active principles.

The best medium for applying these solutions is a double layer of old, soft flannel, of suitable size and shape, well wrung out, and kept constantly wet by pressing the fluid upon it with a sponge; reimmersion, always troublesome, if not painful, being thus obviated. Substitution is effected whenever the cloth becomes soiled and offensive by the discharges. When the application is used warm, a covering of oiled paper or oiled silk is employed to confine the heat and moisture, otherwise the parts are exposed to the air, and the cold may even be increased by means of ice applied in a thin gum-elastic bag.

6. *Nitrate of Silver.*—There is no article which enjoys a higher reputation, as a local antiphlogistic agent, than nitrate of silver; certainly none that is more frequently em-

ployed. Without understanding its precise mode of action, experience has taught us its great value in the treatment of a large number of inflammatory affections, some of which it would be exceedingly difficult to cure without it, while nearly all are more or less benefited by it. Ever since its introduction, in 1826, into practice by Mr. Higginbottom, of England, as a topical antiphlogistic, it has been employed in almost every form of external inflammation, both in a solid and a fluid state. Its beneficial effects in diseases of the eye, throat, and genito-urinary organs have long been well known. In cutaneous affections, too, it enjoys a high and well-deserved reputation. In erysipelas, it is perhaps more frequently used than any other single remedy, iodine alone excepted. Its value in the treatment of this disease, so common in this and other countries, is fully established, both in a prophylactic and curative point of view. In inflammation of the tonsils and fauces, whether the result of ordinary causes, of a strumous diathesis, or a syphilitic taint of the system, no article is so generally employed, or enjoys so great a reputation as nitrate of silver. In gonorrhœa and gleet, in stricture and morbid sensibility of the urethra, in spermatorrhœa, in vaginitis, and metritis, nitrate of silver has become an indispensable means of cure. Indeed, it would be difficult to find an accessible disease, attended with preternatural vascularity and disordered structure, in which its application would not be productive of benefit.

Nitrate of silver may be used as a vesicant, as when it is applied to the skin, or simply as an alterant, or modifier of diseased action; for, as already stated, nothing definite is known of its mode of operation. When employed for blistering purposes, the solid form is usually preferred, the stick being passed lightly but efficiently over the surface, previously well cleansed and a little moistened with soft water, until there is evidence of slight coagulation of the albuminoid matter of the epidermis. A cloth, pressed out of warm water, is then applied, when vesication will soon follow. The same result may easily be produced by a saturated solution of nitrate of silver; but, as the remedy is less manageable, it is not often employed with that view. Unless applied in a very concentrated form, and for an unusual length of time, nitrate of silver never destroys the tissues, or acts as an escharotic.

Solid nitrate of silver is often used with great advantage in ulceration of the mouth and throat, cornea, skin, vagina, and uterus, the application being usually made very lightly, and repeated at suitable intervals. Employed too frequently or too abundantly, it often does immense harm, not only occasioning severe pain, but sometimes seriously aggravating the morbid action. These effects may be produced equally by a strong solution as by the solid stick. A strong collyrium of nitrate of silver has destroyed many an eye, or urged on an inflammation, perhaps on the very verge of resolution, to a most distressing extent. Urethritis is often aggravated, and greatly protracted, by a strong injection of this description. Much judgment, then, it will be perceived, is requisite in the local use of this remedy, not only as it respects its strength, but also the mode and time of its application. Carefully adapted to the exigencies of each particular case, it exerts a powerful antiphlogistic impression upon the diseased structures, diminishing vascular action, relieving pain, and destroying morbid sensibility, often so conspicuous in inflammation of the eye and throat, and which nothing else can so well control.

7. *Iodine.*—Iodine first introduced to the notice of the profession as an antiphlogistic agent by Mr. Davis, of England, is, like nitrate of silver, a most useful topical remedy. It is generally employed in the form of the officinal tincture, either pure or diluted with alcohol. Its great value consists in its alterant and sorbefacient properties, changing the action of the capillary vessels, and promoting the removal of effused fluids. That this is the case is sufficiently apparent from what takes place in erysipelas of the skin, where the effects of the remedy may always be easily watched. Within a few hours after the application the swelling is usually so much diminished as to cause a marked corrugation of the surface, attended with a diminution of pain and hardness; circumstances plainly denotive of lessened vascular activity, and progressive absorption. Similar effects are witnessed when the application is made to an œdematous uvula, scrotum, or eyelid, there being not only no further effusion afterwards, but a removal of what was previously deposited. From these facts, it may be inferred that iodine, locally employed, is not merely a sorbefacient, but also an alterant, or modifier of secernent action.

As an antiphlogistic, iodine is of very great value. In the treatment of erysipelas, I have found no article at all comparable to it as an endermic remedy. It is also of great service in boils, carbuncle, whitlow, corns, bunions, and inflamed, irritable ulcers of the extremities. Its beneficial effects are hardly less conspicuous in active œdema of the

uvula and tonsils, legs, scrotum, prepuce, and pudendum, a single application often sufficing to produce the most marked change in the condition of the part. As a collyrium and an injection, the value of iodine has not been sufficiently tested to enable us to form any definite opinion, but the trials that have been made with it, in this respect, are encouraging, and deserving of repetition.

For external use, the tincture of iodine should generally be diluted with an equal quantity of alcohol, the mixture being brushed on with a camel-hair pencil until the skin is of a deep yellowish, brownish, or mahogany color. The application may be repeated every eight, twelve, or twenty-four hours, according to the exigencies of the case. If the remedy be used stronger than this, it will be very apt to produce severe pain and to excite capillary action; two circumstances concerning which it is impossible to exercise too much caution. When intended for the tonsils, uvula, and other delicate parts, the dilution should, for the reason just mentioned, be still greater.

8. *Compression.*—Compression, as an antiphlogistic agent, is too much neglected, nor is it always judiciously used. That it is capable of doing an immense deal of good, when employed with proper care, and under suitable circumstances, my experience fully justifies me in asserting. Why it is so rarely used, it is difficult to determine, unless it is that practitioners do not possess the requisite skill in its application and mode of management.

Although more particularly applicable to the latter stages of inflammation, compression is not without its value in the incipient and gravescent forms of the disease. Affording support to the affected structures, it is well adapted, when early employed, to give tone to the distended capillaries, enabling them to urge on their sluggish contents, and, consequently, to prevent their effusion into the surrounding tissues. Immense good is often done in this way, as every one knows who has ever treated erysipelas, wounds, fractures, and dislocations, by compression. If two cases of any one of these affections, of precisely the same character, could be treated, one with, and the other without the bandage, simply by the ordinary topical remedies, the difference would be found to be most striking. The compressed limb would be comparatively free both from pain and swelling, whereas the other would be highly sensitive and greatly enlarged, from inflammatory deposits. We see, in such circumstances, how, in the one limb, action is controlled, and how, in the other, it pursues its wayward course. But this is not the only benefit which systematic compression is capable of affording. When judiciously employed, it controls muscular action, and thus prevents spasm, both of which are frequently so annoying in fractures, dislocations, amputations, and various affections of the joints. Another effect, by no means the least striking and important, is the sorbefacient influence which it exerts, rousing the absorbent vessels, and compelling them to remove the fluids that were deposited prior to the employment of the remedy. It is for this reason that compression may be so advantageously used in the latter stages of most of the external inflammations, attended with effusion of serum and fibrin, there being no means known to the surgeon so well calculated to effect this important object, and to assist in restoring the functions of the suffering parts. The treatment of orchitis by compression affords a satisfactory illustration of the mode of action of the remedy under such circumstances. When this disease has been shorn of its violence by depletion, the swelling and induration, consequent upon the morbid action, often promptly disappear under the influence of systematic compression; generally, indeed, in one-fifth of the time they do under the use of mercury and ordinary sorbefacients. The absorption is frequently so rapid as to render it necessary to change the dressings twice in the twenty-four hours. Similar effects are sometimes observed in inflamed and enlarged joints.

The means of compression are the common roller and adhesive plaster, applied in such a manner as to make gentle and equable pressure over the whole of the affected structures. When the part admits of it, the bandage deserves the preference, as it is more easily managed, and equally efficient: but there are certain organs, as the testicle and mamma, where adhesive strips alone can be used. When an additional sorbefacient effect is desired, strips of ammoniac and mercurial plaster may be substituted for the ordinary plaster.

9. *Necrotics.*—Necrotics are remedies designed, as their name denotes, to destroy the germs of certain diseases, as that of chancroid, hydrophobia, and malignant pustule, and to neutralize certain poisons, as that of the snake and of the dead subject. Their action is either curative or prophylactic; most generally the latter.

The most speedy and effectual remedy for an incipient chancroid is the destruction

of the affected tissues with some escharotic substance, as nitric acid, bichloride of mercury, or acid nitrate of mercury. The structures inoculated by the poison of hydrophobia and malignant pustule should be treated in a similar manner, or be excised. When the knife is not admissible, on account of the timidity of the patient, the best remedy, according to my observation, is acid nitrate of mercury, in the form of the officinal solution, applied by means of a soft piece of wood, as a common match, or the point of a probe, inserted, if possible, into the part, and held there until the tainted tissues are completely devitalized. The same remedy, either pure or properly diluted, is admirably adapted to the treatment of phagedenic ulcers and spreading gangrene, by whatever cause induced. It should not, however, be used without due precaution, as it is an agent of great power, and may extend its destructive influence far beyond the diseased limits. The ordinary nitric acid is less manageable than the acid nitrate of mercury, from its liability to diffuse itself over the adjacent parts, and is therefore seldom used as an escharotic. Bichloride of mercury, dissolved in alcohol, in the proportion of two scruples to the ounce, is a most efficient caustic, producing a thin, soft, grayish eschar, which separates in a few days. It is used chiefly in venereal buboes, and acts most promptly when its application is preceded by a blister. A powerful escharotic effect may be produced by a combination of three parts of bichloride of mercury with one of opium, made into a thick paste with concentrated sulphuric acid. The only objection to these preparations is the excessive pain they occasion.

Similar means may be employed for neutralizing the poison of the rattlesnake and other venomous reptiles, and for destroying the virus of wounds received in the dissection of dead bodies. In the former case, free excision is practised, followed by the use of the hot iron, or some escharotic substance ; in the latter, the part is held for a considerable time under a stream of cold water, then well sucked, and next thoroughly cauterized with acid nitrate of mercury.

10. *Counter-Irritants.*—Counter-irritants are remedies which, when applied to the surface of the body, excite a new disease, or a new action, in a part more or less remote from the one originally affected. They are never, or at least very seldom, used until after pretty thorough depletion has been practised, by which the inflammation has been relieved of its violence, as their effects are then always more prompt and decided. The new disease is generally established close to the original one, but occasionally at some distance from it. Thus, in inflammation of the hip-joint, the counter-irritant is applied as near as possible over the acetabulum and head of the thigh-bone, the immediate seat of the morbid action, and so with the other articulations. In disease of the neck of the bladder and prostate gland, it is applied to the perineum ; of the pleura and lungs, over the nearest point of the chest. In inflammation of the eye, on the contrary, the irritation is established on the nape of the neck, behind the ear, or on the arm, not in the immediate vicinity of the suffering organ. Great judgment is often required to determine the precise point where, as well as the precise time when, the new action ought to be instituted. If it be too near the original affection, it may run, as it were, into it, and thus aggravate instead of mitigating the mischief; if, on the other hand, it be too remote, it may entirely fail of the object for which it was employed. Counter-irritation, as already stated, is never resorted to until the system has been relieved of plethora, and the morbid action weakened by other remedies. Used in the height of the morbid action, it can scarcely fail to be productive of local and constitutional disturbance, calculated to exercise a prejudicial influence upon the progress and termination of the case.

Although the class of counter-irritants comprises a large number of articles of a very diversified character, they may with great propriety be arranged under two heads, according to their mode of action, as vesicants, and suppurants.

(1.) *Vesicants* are remedies which, when applied to the skin, elevate the epidermis in the form of blisters filled with serum. They are of great value in the treatment of inflammation, both acute and chronic, and are applicable to a great variety of circumstances, with which the practitioner should be fully acquainted. The articles commonly used for this purpose are cantharides, either in powder or in the form of collodion-liquid, ammonia, and hot fluids. In acute disease these means, especially the first, are always preceded by active depletory measures, otherwise they are liable to do mischief by increasing the local and general excitement. In chronic inflammation, however, they may often be advantageously used at the very commencement of the treatment. The vesicating agent is generally placed as near the affected part as possible ; sometimes, indeed, directly over it.

Blisters, properly so called, are prepared with the common fly ointment of the shops, and vary in shape and size according to the object they are intended to fulfil, or the region to which they are applied. The part, if covered with hair, is previously shaved, and the plaster is confined with a compress and roller, or, what is better, with a few adhesive strips. To prevent strangury, an object of great importance, particularly in nervous persons and young children, the surface of the blister should be sprinkled with a few grains of morphia and camphor. The same end may be attained, although less certainly, by the interposition of a piece of tissue paper, steeped in spirit of camphor. In addition to these precautions, free use should be made of cooling drinks, either alone or in union with spirit of nitrous ether. There is no particular advantage in mucilaginous fluids, as flaxseed tea and gum arabic water, so generally prescribed during the application of a blister, as they do not exert any specific influence upon the renal secretion or the mucous membrane of the urinary passages. If strangury occur, prompt relief may usually be afforded by a laudanum enema, and hot fomentations to the genitals and hypogastric region, aided, if necessary, by a full dose of morphia administered by the mouth, rectum, or skin.

A blister should, on an average, remain upon the part from six to eight hours, unless the skin is very delicate and sensitive, when a shorter period may suffice. In children, in whom the desired effect is usually produced in from two to three hours, it is necessary to be very careful, otherwise violent inflammation and even gangrene may ensue. I have seen horrible suffering, and in two instances, death, follow the application of a small blister in children. In the very aged and infirm, similar accidents occasionally happen. Parts affected with paralysis often suffer severely from the protracted use of blisters. The plaster need not, in general, be kept on until there is thorough vesication ; it is sufficient if the skin is quite red, or if there be here and there a little vesicle, the process being speedily completed by the warm water dressing, or a light emollient poultice. It is of great consequence to remove every bit of the salve, and also not to break the epidermis, but simply to puncture it with a large needle or small bistoury, to admit of the necessary drainage, it being a matter of great moment to exclude the air from the raw surface beneath. The dressings already mentioned may be continued until new skin has formed. Should the surface, however, become red, inflamed, and irritable, bleeding upon the slightest touch, and rendering the patient feverish and restless, recourse must be had to the starch, arrowroot, or slippery-elm poultice, or, what is more soothing than anything else, a thick layer of common white lead paint, covered with cotton, the whole being supported with a roller. A powder composed of equal parts of cinchona and prepared calamine dusted upon the surface is also an excellent remedy. Pencilling the part with a weak solution of nitrate of silver has sometimes a good effect, as has also the ointment of the oxide of zinc, especially when the surface is studded with large irritable granulations.

Cantharidal collodion is a more elegant preparation than the common fly-plaster, and may therefore advantageously take its place, the more especially as its effects are equally strong and lasting. It is best applied by means of a camel-hair brush, the surface to be vesicated being thoroughly coated with it, and the evaporation of the ether restrained by moist patent lint covered with oiled silk. Unless this precaution be used, the article will require nearly as long a time to produce its specific influence as an ordinary blister. The principal advantages of cantharidal collodion are, that it can be more evenly applied to the skin, does not shift its position, is more rapid in its action, and is less liable to produce strangury, especially if it contain, as it generally should, an addition of morphia.

Cantharidine blistering tissue is another elegant preparation for vesicating purposes : easily applied and removed, producing its effects promptly without strangury, and leaving no sores.

Ammonia is used only when a strong and immediate effect is desired, as, for example, in croup, where the inflammation, if not promptly checked, may speedily destroy life. Equal parts of lard and powdered hartshorn produce small vesicles in five or six minutes ; and similar effects follow the application of Granville's lotion or liquid ammonia. Boiling water, the concentrated mineral acids, and the heated iron, cause rapid vesication. All such applications, however, are very painful, and they can never take the place of cantharides. Perhaps the least exceptionable article of this class of vesicants is nitrate of silver, which often blisters the skin in a few minutes, especially when it is very delicate, and has been previously well cleansed. The remedy is particularly adapted to infants and children, as it is never followed by sloughing and other ill effects.

(2.) *Suppurants* are the most powerful of all counter-irritants. They are much more permanent in their character than vesicants, and are therefore more serviceable in eradi-

cating chronic disease. As their name implies, the discharge which they produce is of a purulent nature, and hence they are sometimes described under the name of pyogenic counter-irritants. The class comprises permanent blisters, setons, and issues, which will receive particular attention in the chapter on Minor Surgery.

SECT. III.—CHRONIC INFLAMMATION.

Chronic inflammation is distinguished from acute by a variety of circumstances, which it is of the greatest importance to be able thoroughly to appreciate and understand. Its study, in fact, is of paramount consequence, and it is not placing too high an estimate upon its value when it is asserted that there is much greater merit in being able to diagnosticate a chronic disease than to determine the nature and seat of an acute one. When a lesion declares itself, openly and boldly, by a well-marked train of symptoms, the practitioner must indeed be ignorant, if not positively stupid, if he cannot discriminate with tolerable accuracy between it and other affections which may simulate, or bear some resemblance to it; but it is very different when the malady is of an obscure, chronic character, lurking in the system, no one, perhaps, knowing where, even after the closest and most patient scrutiny. It is under such circumstances that the intelligent pathologist and observant practitioner often appears to the greatest advantage, by turning his knowledge to the best account for his patient.

It does not comport with the design or scope of this work to enter into any of the more minute details of this subject; a large volume might be written upon it, and even then it would not be exhausted. A mere sketch of its more prominent features is all that I shall attempt.

Chronic inflammation is of great frequency, and is liable to appear in all organs and tissues of the body; it is generally a consequence or sequel of the acute form, but cases occasionally arise in which it would seem to be a primary affection. Strictly speaking, such an occurrence is of course impossible; all that is meant when the word is used in this sense, is that the disease which it serves to designate is of so stealthy and insidious a character as to escape, at least for a considerable time, the attention both of the patient and his physician; the person is unwell, perhaps occasionally a little feverish, or the subject of headache, want of appetite, or a sallow complexion and constipated bowels; or, it may be, he has a cough, and a pain in his side; or a joint becomes sore and stiff; and still he is able to go about and attend to business, although he is soon fatigued, and rendered uncomfortable by it. Thus a week, a fortnight, or a month may be passed, when, a careful examination being instituted, the discovery is made that there is a grave disease in some important organ, and that it has perhaps already gone so far as to render recovery absolutely impossible, however skilfully the case may now be treated. The disease has been latent, or nearly so; it has failed to make itself known by any distinctive train of phenomena, and both patient and practitioner have been lulled into fatal security. The morbid action has been lying all this time in ambush, and is now, in the true sense of the term, chronic. Such cases are by no means infrequent, and they should serve to admonish us never to neglect any symptoms, however trivial, in our clinical investigations. A pain, a soreness, a cough, a halt in the gait, may, if properly interpreted, afford useful information in regard to the diagnosis of chronic disease, and should teach us the value and importance of patience and caution in the examination of the sick. The slightest neglect may be fatal; a little spark may kindle a devouring flame.

Chronic inflammation, however provoked, is generally tardy and sluggish in its movements, creating little constitutional disturbance, but not, on this account, the less surely and effectually undermining the part and system. In the acute variety, the action is rapid, bold, daring; suffering is severe; and constitutional response loud and unmistakable. In chronic inflammation, on the other hand, the symptoms are, as already stated, often obscure, if not absolutely masked, and the embers of disease never break out into open flame. The disease may continue for weeks and months; now stationary, smothered, or apparently receding; now advancing, and seemingly almost ready to assume the acute type.

The origin of chronic inflammation is often, if not generally, intimately connected with disorder of the digestive apparatus; seemingly, at all events, the first link in the chain of morbid action is frequently referable to the state of the stomach and bowels, especially to the effects of dyspepsia or constipation. Idiopathic inflammation of the eye and other organs often owes its origin to gastro-intestinal irritation. At other times the

disease is awakened by derangement of the menses, defective action of the kidneys, suppression of the cutaneous perspiration, or disorder of the biliary secretion. Anxiety of mind, grief, anger, fatigue, intemperance in eating and drinking, and inordinate sexual indulgence, are all so many predisposing and exciting causes of chronic inflammation.

The effects of this form of disease are various; if not closely watched and soon checked, it may prove fatal by the induction of serious structural changes, which neither nature nor art may be able to repair. The most common and important of these changes are suppuration, ulceration, softening, adhesion, contraction, induration, and enlargement, according to the intensity of the morbid action, the texture and situation of the affected organ, and the condition of the general system. The formation of pus and molecular disintegration, whether by softening or ulceration, are exceedingly common attendants upon this variety of inflammation, and often proceed to a most destructive extent. Adhesion is most liable to occur in the serous tissues; contraction, in the bloodvessels and excretory tubes. Induration and enlargement usually coexist, although occasionally they occur independently of each other. Examples of these two changes are constantly met with in surgical practice, especially in the lymphatic glands of the neck, axilla, and groin, in chronic disease in and around the joints, in various affections of the skin, connective tissue, and bones, and in inflammatory hypertrophy of the tonsils, testicle, mamma, and prostate gland. When existing in a high degree, they lead to serious functional embarrassment of the affected parts, growing out of alterations of structure, which the best directed efforts of the surgeon often fail to relieve.

Gangrene, as an effect of chronic inflammation, is rare; nevertheless, it is occasionally met with, as is witnessed, for instance, in the mortification of the toes and feet, so graphically described by Pott, and dependent upon ossification, inflammation, or embolism of the arteries. In most cases, when the disease passes into gangrene, it first assumes the acute type, which renders the transition much easier, and, in some degree, a necessary preliminary.

The symptoms of chronic inflammation are generally much less prominent than those of the acute variety; the pain is less, and usually also more dull or obtuse; the discoloration is dusky, livid, or purple; the swelling, often considerable, is characterized by unusual hardness, or by hardness and œdema; and the heat is nearly always less than in acute inflammation. Functional disturbance is variable, being extensive at one time, and slight at another. Symptomatic fever may be entirely wanting, and it is this circumstance which so frequently causes this variety of inflammation to be overlooked, especially when it is of idiopathic origin. In time, the fever may assume a hectic type, or it may be of this character almost from the commencement. When the disease is extensive, or seated in an important organ, adynamic fever generally exists.

The vessels of the affected parts are generally very much dilated and distended with red and white globules, on which account the blood is propelled through them in a very tardy and sluggish manner, strikingly contrasting with the force and rapidity with which it is transmitted in the acute form of the disease, where, especially in its earlier stages, all is power and activity. When the inflammation is very protracted, many of the smaller vessels have a varicose, tortuous appearance, and are so crippled as to be almost unable to send on their contents at all. Hence, congestion, often deep and extensive, is generally present, both at the focus of the morbid action and for a considerable distance around.

Treatment.—In the treatment of chronic inflammation, the indications are, first, to remove the exciting cause of the disease; secondly, to correct constitutional disorder; thirdly, to promote the absorption of effused fluids, and, lastly, to restore the tone of the crippled and dilated vessels.

The removal of the exciting cause of the disease obviously demands the same attention here as in the acute variety of inflammation; whenever it is accessible, it should be promptly disposed of. All officious interference must of course be avoided.

Restoration of the secretions constitutes a most important indication, as it is upon their derangement or suppression that the morbid action in chronic inflammation so often depends. The remedies that are chiefly to be relied upon, for this purpose, are mercury, tartrate of antimony and potassium, iodine, nitromuriatic acid, purgatives, and a judiciously regulated diet.

In placing mercury at the head of this list of remedial agents, I simply desire to show the high estimate that is so justly attached to it in the treatment of chronic inflammation. If its administration is of doubtful propriety in many cases of the acute disease, there are few instances of the chronic in which it may not be beneficially exhibited; and yet,

in making this remark, it must not be understood that it is to be given indiscriminately or sakelessly. Its value is unquestionable, but, still, there are cases and circumstances in which it is utterly inadmissible; this is especially true of those cases of chronic inflammation which are so often met with in scrofulous children, and in persons of enfeebled and broken constitution, where mercury, in almost any form, is generally most pernicious, the smallest quantity sometimes producing profuse ptyalism, or gangrene of the mouth.

In administering this remedy for the cure of chronic inflammation, the surgeon has it in his power to make choice of a much greater number and variety of articles than in acute inflammation, in which he is obliged to restrict himself chiefly to calomel and blue mass. In the chronic form of the disease, he has, in addition, the bichloride, the protiodide and cyanide, which exert a most salutary influence in changing the capillary action of the part, and promoting the removal of effused fluids. Whatever substance be selected, the dose should be very small, and not repeated oftener, on an average, than twice or thrice in the twenty-four hours. The object is to produce a slow and gradual effect, and for this purpose it will generally be necessary to continue the remedy for several successive weeks. Active ptyalism is carefully avoided; it will be quite sufficient if we succeed in obtaining slight soreness of the gums. If calomel be used, a good average dose will be from one-sixth to one-half of a grain.

In children, the most suitable mercurials are blue mass, corrosive sublimate, and gray powder, or mercury with chalk, given either alone or in union with sodium and columba, quinine, or Huxham's tincture of bark.

Iodine and its various preparations, as iodide of potassium, iodide of iron, iodide of cadmium, iodide of ammonium, and Lugol's solution; bromide of potassium; barium; and tartar emetic often exert a most salutary influence over chronic inflammation, and are particularly indicated where a slow, alterant effect is required. With the exception of mercury, I know of no article of the materia medica which produces so powerful an effect as tartar emetic in controlling chronic inflammation, and favoring the absorption of effused fluids. The proper plan is to give it in small doses, as the eighth, tenth, or twelfth of a grain, in combination with some vegetable bitters and a little morphia, three times in the twenty-four hours.

The different acids are sometimes administered with advantage, especially the dilute nitromuriatic, formerly so much employed in the treatment of hepatic affections. They are particularly indicated in chronic syphilitic and scrofulous inflammations, attended with impaired digestive powers.

The bowels must be kept in a soluble condition, the nature and dose of the purgative being regulated by the exigencies of each particular case. The compound calomel pill, which, while it operates on the bowels, and excites the action of the liver and skin, constitutes one of the most eligible cathartics we possess in the treatment of chronic inflammation, accompanied with visceral obstruction.

Particular attention should be paid to the skin. This will appear the more necessary when we consider that, in most cases of chronic disease, the perspiration is either entirely suppressed, or greatly changed in its properties. Frequent ablutions with cool, tepid, or warm water, impregnated with common salt, soap, mustard, or potassa, and followed by dry frictions, often prove highly serviceable. In many cases the cold bath will be found to be extremely valuable, especially if the surface be well rubbed immediately after with a coarse cloth. The renal secretion should also receive proper attention; sometimes elaborate chemical and microscopical examinations will be required to determine its character, and enable us to direct a suitable plan of treatment.

Exercise in the open air, either on foot, in a carriage, or on horseback, often effects a wonderful improvement in chronic inflammation, especially when of long standing, and attended with great debility. At other times, nothing but the most perfect rest will answer the purpose; as, for example, in serious disease of the brain, bones, and joints.

The subject of diet claims special attention in the treatment of chronic inflammation. The indiscriminate use of food in this form of disease cannot be too severely reprehended. Too great abstinence, however, is often as injurious as too great indulgence. All stimulating and indigestible articles should, as a rule, be avoided as likely to increase the local disease, and exercise a prejudicial influence upon the patient's recovery. If the system is inclined to plethora, the diet should be of a strictly farinaceous character, and be limited daily to a few articles, varied from time to time as they become disagreeable to the palate, or offensive to the stomach. If, on the other hand, the patient is pale and feeble, it should be partly farinaceous, and partly animal, the meat being taken at breakfast and dinner, and its effects carefully watched. The different kinds of animal and vegetable broths,

beef-essence, milk, arrowroot, rice, sago, tapioca, hominy, and grits, are all eligible articles in chronic inflammation, and often prove of the greatest service in nourishing and sustaining the system. Their flavor and efficacy may be improved by the addition of spices, wine, or brandy, as may be deemed proper. When the patient is much exhausted, the use of whiskey, brandy, wine, ale, or porter will often be indispensable to recovery. Cod-liver oil may be employed when there is marked debility along with emaciation; rather, however, as an article of nourishment than with a view to the attainment of any alterant effect it may be supposed to possess from the presence of iodine and bromine. The dose should be as large as may be consistent with gastric tolerance.

Finally, in the female, proper regard must be had to the state of the menstrual function; prompt measures being adopted for its improvement, or, in the event of its suppression, for its restoration. There are numerous complaints which owe their origin, either directly or indirectly, to disorder of the uterine functions.

The local treatment of chronic inflammation is generally a matter of paramount importance. It comprises, first, as in acute disease, rest and elevation of the parts; secondly, leeching, scarification, blistering, iodine, and nitrate of silver, especially in the early stages; thirdly, counter-irritation by croton oil, tartar emetic, issues, and the actual cautery; and, lastly, sorbefacients, such as stimulating liniments, embrocations, and unguents, the cold douche, compression with the bandage, or adhesive strips, electricity, and massage, the latter of which is often of immense service. When the parts are hot and tender, solutions of acetate of lead, or evaporating lotions, are generally highly beneficial, if not indispensably necessary. In obstinate cases, electricity is sometimes useful, although its effects have been greatly overrated.

CHAPTER IV.

TERMINATIONS AND RESULTS OF INFLAMMATION.

SECT. I.—DELITESCENCE AND RESOLUTION.

THESE terms are used to denote the restoration of the inflamed structures to their normal condition. The word delitescence is of Latin derivation, and literally signifies to abscond; it was introduced into surgical nomenclature by the French writers, and is employed to designate the sudden disappearance of inflammation, before it has passed through its different stages, and, consequently, before it has occasioned any serious structural changes. It is unquestionably the most desirable mode of termination, and may occur either spontaneously, or from the slightest treatment. A catarrh, caused by exposure to cold, and perhaps threatening to be quite severe, often aborts during a profound sleep induced by a warm bed, or a hot foot-bath and a little morphia. An inflammation of a lymphatic gland of the neck, coming on late in the evening, and attended with great tenderness on motion and pressure, together with considerable swelling, often rapidly disappears under similar measures. An incipient gonorrhœa frequently aborts under the use of a mild injection of nitrate of silver or acetate of lead; and who has not seen a bubo promptly vanish under steady, systematic compression, aided by the application of iodine? Inflammation produced by the presence of a foreign body generally rapidly disappears after the removal of the exciting cause of the morbid action.

The above facts, as well as many others that might be adduced, are pregnant with two most important lessons, one of which is to remove as early as possible the exciting cause of the inflammation, and the other to lose no time in instituting a proper method of treatment for the relief of the morbid action. The object should invariably be to save structure, and the best way to do this is to compel the disease to abscond, or delitesce. Such an event, however, is only desirable when the inflammation can be dislodged more or less completely without any risk of throwing it upon some other and, perhaps, more important organ. Thus, an attack of gout in the great toe would be a trifling affair in comparison with an attack of gout in the heart, brain, or stomach; and hence it would be far better, when there is danger of such a translation of irritation, to let the original disease pursue its course, than to attempt to arrest it by means tending to favor such a result. A severe injection may suddenly arrest an incipient gonorrhœa, but it may do infinite harm by the

rapid induction of orchitis, which perhaps no treatment, however judiciously conducted, may be able to dispel completely under several weeks, or even months.

The sudden disappearance of inflammation from one structure, or set of structures, and its invasion of another, usually known by the term metastasis, suggests the importance of proper watchfulness on the part of the surgeon to prevent such an occurrence ; or, if it have already taken place, of employing such means as shall serve to recall the morbid action as speedily and effectually as possible to its original situation.   For this purpose free use should be made of counter-irritation, in the form of stimulating embrocations, sinapisms, or blisters, aided, if the organ affected be one of great importance to life, by the abstraction of blood and the free use of opiates.   If, in this way, the disease cannot be recalled, the treatment will go far to put a speedy stop to its violence and its tendency to extension.

The term resolution denotes the gradual dissipation of inflammation after the disease has made some progress and done some mischief, but before it has reached the suppura-tive crisis, or committed such ravages as to prevent the affected tissues from regaining their original properties.   With such an issue effusion of serum and lymph is not at all incompatible, as these fluids may be entirely absorbed ; a similar remark is applicable to pus, provided it exist in small quantity, or not as an abscess, in which there is always more or less waste of tissue ; and even to pure blood, which, if not too abundantly effused, or deprived of its vitality, is generally readily amenable to the action of the absorbents.

When resolution is about to occur there is a gradual and steady subsidence of the mor-bid action, as denoted by the changes in the local and constitutional symptoms.   The discoloration, heat, pain, and swelling become less and less through the contraction of the vessels and the absorption of the effused fluids ; the febrile disturbance passes off ; and the part and system, no longer influenced by the effects of the disease, at length regain their normal condition.   Often many weeks, and even several months, elapse before the restoration is finally completed.   The absorbent vessels, kept in abeyance by the vascular action and the effused fluids, are slow to resume their functions ; they act at first hesita-tingly, as if afraid to enter upon their labor, but as the work progresses they acquire con-fidence, and, at length, setting about it in good earnest, they ere long finish their task, drinking in, as it were, all that their oppressors, the secernents, had previously poured out, and thus leaving the parts in a condition to regain their primitive characters.   The bloodvessels usually remain dilated, feeble, and sluggish for some time after the complete subsidence of the disease, and there is also frequently more or less perversion of special sensation.

<center>SECT. II.—DEPOSIT OF SERUM.</center>

A deposit of serum, or of the watery elements of the blood, is a common attendant upon inflammation, and in some cases constitutes, pathologically speaking, the principal, if not the only, evidence of its presence.   The structures which, when thus affected, supply serum in greatest abundance, are the connective and serous, the secernent vessels of which are generally extremely active, even when the disease is comparatively mild.   Large quantities of serum are also occasionally poured out by the mucous membrane of the ali-mentary canal, especially by that of the colon and rectum, as in diarrhœa and cholera. Inflammation of the skin, unless produced by scalds, blisters, erysipelas, and the various bullar diseases, yields this fluid generally sparingly.   Very little is also effused in inflam-mation of the muscles and fibrous membranes, the nerves and vessels ; while tendon, car-tilage, and bone do not afford any, however severe the morbid action.   A similar remark is applicable to inflammation of the parenchymatous and glandular organs, as the lung and liver.   In the connective tissue serous accumulations are particularly liable to occur wherever this substance is very loose and abundant as in the eyelids, scrotum, prepuce, labia, nymphæ, legs, and feet, which are often enormously distended in consequence.   (Edema of the glottis is an example of watery deposit in the submucous connective substance of the edges of the larynx.   In the splanchnic cavities and the movable joints serum often collects in immense quantities ; sometimes as an effect of acute, but more frequently of chronic, inflammation.

Particular epithets are employed to designate certain collections of serum, based either upon the appearance of the part, or the anatomical name of the cavity that serves to re-ceive the fluid.   Thus it is customary to speak of œdema of the glottis, of œdema of the eyelids, and of œdema of the legs, simply because these structures, when thus affected, have a swollen, glossy aspect.   The older writers applied the word anasarca to all aqueous accumulations of the inferior extremities, under the supposition that the fluid was diffused

through the muscles. Dropsy of the leg is another familiar expression. The latter term, however, is generally restricted to collections of serum in the various cavities of the body, as dropsy of the abdomen, chest, head, pericardium, joints, and vaginal tunic of the testicle. Or, instead of this term, a Greek one, either simple or compound, is used, as being somewhat more classical. In this manner a dropsy of the abdomen becomes an ascites; of the chest, a hydrothorax; of the head, a hydrocephalus; of the vaginal tunic, a hydrocele.

Although serum is generally limpid in its appearance, cases now and then arise in which, from the admixture of hematin, bile, or other extraneous matter, it is reddish, dark, yellowish, or even milky. A dark appearance, such as is so generally present in the peritoneum in strangulated hernia, is to be viewed as an evidence of intense inflammation. A similar phenomenon is witnessed in the blebs of incipient gangrene, and in the enormous accumulations of serum which occasionally occur in the limbs in consequence of snake bite and other severe injuries.

The fluid, which sometimes contains flakes of fibrin, pus, and even pure blood, is unctuous to the touch, saline in taste, but free from odor, and is readily coagulable by alcohol, heat, acids, and corrosive sublimate; circumstances which show that it is composed principally of albumen, in combination with some of the earthy salts, especially the sulphates. Its quantity in acute inflammation is usually small, except in the splanchnic cavities, where it is sometimes immense, amounting to many quarts, or even several gallons.

Great diversity of sentiment has been expressed in regard to the kind of action under the influence of which this fluid is produced, some declaring that it may be effused independently of inflammation, while others maintain that inflammation is indispensably necessary. I have long been of the latter opinion, nor is it possible, it seems to me, to arrive at any other conclusion, unless it be assumed that there is no inflammation without suppuration, or, at least, without fibrinous exudation, a doctrine so utterly at variance with the facts of the case as to render its adoption impossible. Inflammation is a very simple process; it requires very little disturbance to induce it, and an effusion of serum often occurs without any of the ordinary phenomena of the disease, as heat, pain, and discoloration. In chronic dropsies, for example, the inflammation is frequently so very slight that, if it were not for the mechanical inconvenience which the fluid occasions, the patient would hardly be conscious of any suffering; and yet, even in such cases, it will generally be found, on dissection, that the serous membrane which furnished the water, exhibits sufficient indication of the lesion in the opaque and thickened condition of its substance. It may be questioned whether mere congestion is capable of producing serous effusion. At first sight such an occurrence would seem to be quite probable; but a careful examination of the subject soon dispels the illusion. Permanent obstruction of the abdominal cava causes ascites, not from mere congestion of the vessels of the peritoneum, but as a consequence of its inflammation, the result of the previous vascular engorgement. It is easy to see that vessels habitually distended must soon take on incited action, followed by abnormal deposits. A familiar illustration of this is afforded in the conjunctiva, where, if the vessels are at all engorged even for a short time, inflammation is sure to follow, unless the exciting cause of the determination is speedily removed. If this mode of reasoning be correct, it follows that obstruction of the circulation, however induced, must, if permitted to continue, be soon succeeded by inflammation, of a grade and character sufficient to cause at least an effusion of serum, if not also of other fluids.

Of the nature of the morbid action, when serum is rapidly supplied, or when it is associated with other deposits, as lymph or pus, there can be no doubt that it is highly inflammatory. The concomitant symptoms, and dissection after death, clearly establish the fact. The rapid and profuse serous exhalations which occur in acute pleuritis, peritonitis, and arachnitis admit of explanation in no other way; they are the appropriate products of these structures, and hence they generally appear very early in the disease.

Effusion of serum is often associated with, if not directly dependent upon, an impoverished and watery condition of the blood, accompanied by a marked decrease of fibrin and red particles. If, under such circumstances, inflammation be lighted up, especially in connective and serous tissues, serum cannot fail to be supplied in large quantities, since, in consequence of the diminution of the plastic properties of the blood, there is nothing to restrain its exudation. Hence such action is very prone to be followed, externally, by anasarca or œdema, and internally by dropsy.

The symptoms produced by this deposit are such, mainly, as are denotive of mechanical obstruction. In the eyelids, glottis, scrotum, prepuce, vulva, and legs, it is marked by a soft, inelastic swelling, which pits on pressure, and imparts a peculiar glossy appearance

to the affected surface : attended, especially in the inferior extremities, with pain, heat, and more or less discoloration, usually of a pale dusky hue. A sense of distention is also commonly a prominent symptom. In œdema of the glottis there is serious impediment in the respiratory functions, while in accumulations of water in the splanchnic cavities there must necessarily be more or less oppression, with displacement of the contained viscera. A large collection of water in the chest may not only cause collapse of the lung on one side, but greatly encroach upon the opposite one, and at the same time throw the heart completely out of its natural position, depress the diaphragm, and tilt up the intercostal spaces so as to give the thorax a vaulted configuration. In infiltration of the connective tissue of the leg, feet, scrotum, and vulva, the fluid may, by its pressure upon the capillary vessels, cut off the supply of blood from the skin, and thus become a cause of mortification, as is exemplified in certain forms of erysipelas and anasarca.

In the treatment of internal serous effusions, the leading indication is to promote the absorption of the offending fluids by the use of hydragogue cathartics, diuretics, and mercurials ; followed, when these means fail, by an operation for their efficient evacuation. The most important cathartics, after thorough purgation, are jalap and bitartrate of potassium, citrate of magnesium, and elaterium, given in doses proportioned to the strength of the patient and the tolerance of the stomach and bowels. These remedies, as well as others of a kindred nature, produce their beneficial effects by establishing a drain upon the serous capillaries of the alimentary canal, which leads indirectly to the absorption of the serous accumulation. When mercurials are required, as in case of obstruction of the portal circle, with deficiency of the hepatic secretion, the most eligible articles are calomel, blue mass, or corrosive sublimate, either alone or in union with elaterium, squills, digitalis, or antimony, according to the nature of the collateral disorder. Deficiency of the renal secretion must be corrected by suitable diuretics.

When the accumulation of serum is very great, as in dropsy of the chest, abdomen, or pericardium, all internal treatment will be likely to prove abortive, as it is then generally impossible to rouse the absorbents, the pressure of the fluid keeping them in a crippled and paralyzed condition, altogether incompatible with the healthy exercise of their functions. Hence, instead of wasting time and the strength of the patient, as is unfortunately too often done in such cases, early vent should be afforded to the pent-up matter. Serious and even fatal errors are constantly committed for the want of early interference with the trocar in these accumulations. It must not be forgotten that purgative, diuretic, and alterative remedies, if available at all, can prove beneficial only at the expense of much distress and exhaustion of the system, which too often leave the sufferer, in the event of his recovery, with permanently shattered health. An operation, on the other hand, generally promptly remedies the urgent symptoms, and places the part in a much more favorable condition for the efficient action of sorbefacient medicines.

Local remedies are available chiefly in serous effusions in the external parts of the body. In œdema of the extremities great benefit is often derived from steady and persistent elevation, and regular, equable compression with the bandage, extending upwards from the distal portion of the limb. In this way support is given to the weakened capillaries, while a salutary stimulus is imparted to the absorbents, increasing their action and thus favoring the removal of effused fluid. This treatment often derives important aid from frictions with sorbefacient unguents, liniments, and embrocations, and the application of dilute tincture of iodine. When the distention is inordinate, or threatens to pass into gangrene, early punctures and even free incisions are called for, although, generally speaking, they are objectionable, as they often bring about the very disease they are designed to prevent. In œdema of the glottis nothing short of prompt and decisive scarification can save the patient from suffocation.

SEC. III.—LYMPHIZATION OR PLASTIC EXUDATION.

Lymphization is the act of separating lymph or plasma from the blood and depositing it in the organs and tissues, or upon their free surfaces. The term bears the same relation to the substance which it serves to designate that the word suppuration bears to pus, the product of that act. As signifying the same thing, the phrase " fibrinous exudation," or " inflammatory exudation," is often used.

There is seldom any inflammation, however slight, without some deposit of lymph. Indeed, in many cases, and in certain situations, it constitutes almost the only product of the morbid action. Thus, in croup and peritonitis, the chief evidence of the existence of these diseases, after death, is the presence of lymph ; in general, however, it is associated

with other deposits, especially serum, which is often poured out along with it in large quantities. When the inflammation is at all severe, and particularly if it have already made considerable progress, there may be, in addition, puriform matter, pus, and even pure blood. Its presence, whether occurring singly or combinedly, is generally denotive of a higher grade of action than the mere effusion of serum.

The capacity of furnishing lymph, in inflammation, is possessed in different degrees by different organs and textures, depending upon the peculiar nature of their structure and organization. The serous membranes, especially the pleura and peritoneum, the connective tissue, and certain portions of the mucous system, as the faucial, laryngeal, intestinal, and uterine, yield it very freely. Very little is effused, under any circumstances, by the fibrous membranes, the muscles and their tendons, the vessels, nerves, cartilages, and bones, except in fractures and other injuries, in which it is sometimes thrown out in great abundance. In some of the parenchymatous organs, as the brain, liver, and kidneys, it is usually supplied very sparingly, whereas in inflammation of the lungs and spleen it is often effused very freely, leading to rapid solidification of their proper structure. Large quantities of lymph are sometimes exhaled during the progress of abscesses, many of which it serves to inclose in a distinct cyst, known as the pyogenic membrane.

Lymph is generally poured out very early in the inflammatory process, and often continues for an indefinite period, increasing and declining with the disease. It is surprising how soon it sometimes shows itself. From experiments that I have performed upon the inferior animals, as well as from observations upon the human subject, I am convinced that it begins much earlier than is usually supposed. In 1841, I had repeated proofs of this fact, while engaged in an elaborate series of experiments upon dogs, with a view of elucidating the nature and treatment of wounds of the intestines. I found, in many of these animals, that the bowels had become extensively adherent, not only to each other, but likewise to the walls of the abdomen, within a very few hours after the operation. In the case of a gentleman whose abdomen I opened, on account of a twist in the small intestine, although death occurred at the end of four hours, nearly the whole peritoneum, visceral and parietal, was coated with a thin film of fibrin, of which hardly any traces existed anywhere at the time of the operation. In another case, that of a young lad, who died within nine hours after he had been shot in the side, the ball wounding the abdomen, diaphragm, and chest, large quantities of lymph were seen both upon the peritoneum and the pleura. The flaps made in an amputation become speedily glazed with fibrin, and the edges of an incised wound frequently adhere quite firmly within a very short time after their approximation.

From the preceding facts, it is evident that the exudation of lymph generally begins at an early period of the inflammation, and that, under favorable circumstances, it proceeds with great vigor. When the reverse, however, is the case, it advances comparatively slowly, or it may even fail entirely. Such an event will be most likely to occur in low and depraved states of the system, attended with anemia and lesion of the innervation.

Plasma, considered as an effect of disease, is a direct product of the vessels of the affected structures, the process by which it is elaborated being one of a vital character, analogous to, if not actually identical with, secretion. Virchow maintains that it has an extravascular origin; or, in other words, that it is a local product of the tissues, on and in which it is found, being essentially composed of the material generated in the inflamed part itself through the changes in its condition. He denies that there is, in the ordinary acceptation of the term, any inflammatory exudation whatever; or, what is the same thing, that there is any actual transudation of the blood-liquor. However this may be, lymph is a vital, organizable, proliferous fluid, susceptible of great changes in its composition, and capable of playing a most important part in injury and disease.

Recently effused lymph is of a whitish, pale straw, or opaline appearance, although now and then it is somewhat reddish, from the admixture of hematin. In cases of protracted jaundice, it is occasionally of a pale orange hue. It is of a soft, unctuous consistence, like hot glue, or a thin solution of starch, is destitute of odor, has a faint saline taste, and is essentially composed of fibrin in union with albumen and serum. Immersion in alcohol renders it tough, and changes its color from white to buff.

Lymph is a vital, organizable fluid, identical in its composition with the buffy coat of the blood. Under the microscope it is found to consist of numerous globules, analogous to colorless blood corpuscles, of a spherical shape, nearly homogeneous, and about the $\frac{1}{2600}$ of an inch in diameter. Delicate fibrils, straight, parallel, and interspersed with innumerable granules, are also visible in it. Although lymph is always poured out in a fluid state, it soon arranges itself in various forms; now as an amorphous mass; now as

a tube, as in the larynx and bowel; at one time as a lamella, and at another as a distinct band; its conformation being materially influenced by that of the organ, tissue, or cavity in which it is effused.

Plasma does not always exhibit the same appearances either under the microscope or to the naked eye. In this respect it shares the same fate as other morbid products. Any differences that it may present are entirely due to differences in the state of the blood, the part and the system in different individuals, localities, and grades of the morbid action. Corpuscular lymph, as it has been termed by Rokitansky, differs from ordinary only, or chiefly, in having a greater number of exudation globules, and less of healthy fibrin. It is generally met with in persons of deficient vital powers, with an impoverished state of the blood, and soon manifests a disposition to break down and become effete. In young, robust persons the lymph poured out in inflammation is generally very firm and abundant, with a strong cell-force, and a tendency to rapid organization. In scrofulous subjects it is almost wholly corpuscular. Its constitution is also materially influenced by the nature of the affected structures and the character and intensity of the morbid action.

Fig. 4 represents a portion of recently effused corpuscular lymph, opaque, white, friable, and magnified about 380 diameters, from an inflamed pleura. It is composed of colorless corpuscles, and granular matter in a hyaline matrix. In the lower part of the figure the corpuscles are shown as floating in serous fluid. In fig. 5, magnified 800 diameters, the structure of the effused matter is somewhat different. It forms, in fact, a sort of false

Fig. 4.   Fig. 5.
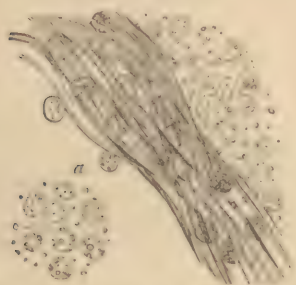
Fig. 4. Plastic Corpuscles and Filaments in recent Lymph exuded on the Pleura. *a* The Corpuscles, unchanged by Acetic Acid.
Fig. 5. Recent Lymph, forming False Membrane.
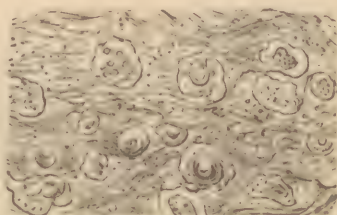
membrane, the croupous exudation of the German authors. Numerous corpuscles, more or less globular, a few epithelial cells, and granular matter, are seen to be interspersed through filaments of fibrin.

The period at which the organization of this substance takes place varies with a number of circumstances, of which the most important are, the plasticity of the effused matter, the nature of the affected tissues, and the state of the general system. To enable it to attain this point at all, it must have a strong cell-life, formative power, or cell-force; if this be wanting the development of cytoblasts will either be impracticable, or so imperfect as to be soon arrested, or, at all events, very much impaired. When everything is favorable, the development proceeds very rapidly; cells and nuclei are formed in great numbers, and these, connecting themselves with each other, are gradually spread out into fibres, lying, for the most part, in straight, parallel lines, and profusely inlaid with granules, as in fig. 6. Soon after this process has begun, vessels appear in the new product, either as a result of the canalization of branched cells, or as an extension from the neighboring structures, the latter being by far the more common source of the supply. The walls of the vessels are, at first, very frail and yielding, so that the least pressure is sufficient to rupture them and cause extravasation of their contents. Gradually, however, as they grow older, they become better qualified for the discharge of their functions, and in time acquire all the properties of the natural vessels. When fully developed, they can easily be discovered with the naked eye, and readily admit fine injecting matter. The veins are usually disproportionately large to the arteries, but this defect also ultimately disappears. Nerves and absorbents likewise exist, but whether they are supplied by the surrounding tissues, or by the inherent powers of the effused matter, is undetermined.

The arrangement of the newly-formed vessels is represented in the annexed sketches. Fig. 9 is a portion of plasma attached by a narrow neck to the peritoneal coat of an

inflamed intestine. The vessels have a ramiform disposition, and freely anastomose with each other. Fig. 10 is a piece of false membrane of the pleura. The vessels are large, numerous, and further advanced than in the other sketch.
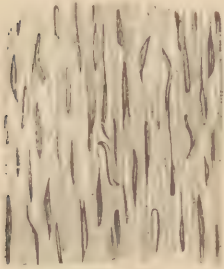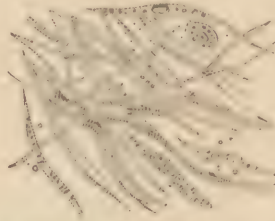
Fig. 6.   Fig. 7.   Fig. 8.
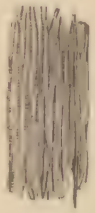
Figs. 6 and 7, from Bennett, show Nuclei and Cells developing themselves into Fibres ; while Fig. 8 exhibits a Perfect Fibrous Tissue.

When the process of organization is unusually rapid, the new vessels, in consequence of their very tender and brittle condition, occasionally give way, either under the influence of external violence, or the force with which the blood is impelled into them by the heart's action. Such an occurrence may be productive of considerable hemorrhage.

Fig. 9.   Fig. 10.

Newly-formed Vessels in Plastic Lymph.   Vessels in False Membrane of the Pleura.
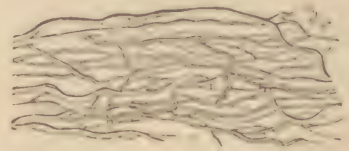
The organization of plasma is sometimes completely prevented by the contact of extraneous matter, as feces or urine. Hence, we seldom meet with a false membrane in the bowel and bladder. The very moment the plasma is poured out it is devitalized and converted into an effete substance. The state of the blood and solids also exercises an important influence upon the process ; the more impoverished and exhausted these are, the less likely will the effused matter be to form cells and nuclei, vessels, nerves, and absorbents.

Plasma is susceptible of absorption both in its fluid state and after it has been changed into connective tissue. This, however, does not occur, at least not to any considerable extent, during the height of the inflammation by which it has been produced ; on the contrary, there must always be a marked reduction of the morbid action before the absorbent vessels can be induced to take hold of it ; but this point having once been attained, the process often goes on very rapidly, as is witnessed in fractures, dislocations, wounds, and other injuries, in which the swelling, chiefly caused by fibrinous deposits, occasionally completely vanishes in a few days. The absorption will necessarily be more difficult when the plasma has become organized, when, in fact, it often effectually resists all the efforts that can be employed to get rid of it. The opaque spot on the cornea, for example, often remains despite the most protracted treatment. It is probable that plasma, before it can undergo absorption, even in its liquid state, is broken up and dissolved in the fluids of the affected parts, being thus brought more readily under the influence of the vessels. In fig. 11 the fibrous matter is undergoing absorption, some parts of the layer being completely removed, while others are becoming softened and attenuated.

Moreover, this substance is liable to various kinds of degeneration, both in its early and in its more matured stages. When recently effused, it may be converted into pus, especially if it be aplastic and exposed to the air ; and it then also frequently becomes hard, dry, shrivelled, devitalized, and effete. It likewise undergoes the fatty transforma-

tion, both before and after vascularization, as exhibited in Fig. 12 ; and, lastly, it is occasionally infiltrated with pigmentary matter.

Finally, organized plasma forms the basis of what are called the analogous tissues, and may, therefore, like the original structures with which it is in contact, become the seat of inflammation, sarcoma, tubercle, and other formations.

Fig. 11.   Fig. 12.
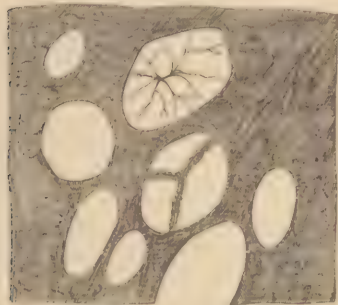
Fig. 11. Fibrinous Exudation in Process of Absorption : Areolæ form in it, and reduce it to Filamentous Bands.
Fig. 12. The Lymph of Pleuritis, with New Vessels and Fatty Degeneration.
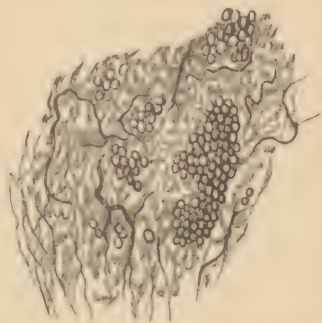
Uses of Plastic Matter.—The great value of this substance is strikingly illustrated in numerous diseases, injuries, and operations.   As a reparative agent, as a living animal glue, as it may very properly be termed, it is impossible to overestimate its importance. If it were not for its interposition, no wound, sore, or ulcer, however insignificant, could ever heal.   In the treatment of an incised wound the duty of the surgeon is strictly mechanical, consisting simply in the approximation of the raw surfaces, and in their retention by suitable dressings.   Nature does the rest by the effusion and organization of plasma, generally well and quickly, provided the parts are kept perfectly cool and quiet. Very little inflammation is required.   The great danger is in overaction, thereby thwarting the efforts at repair.   Under proper management the wound generally heals in a few days, the bond of union becoming hourly more and more firm by the gradual conversion of the plasma into connective tissue, of which, however, very little ordinarily remains when the process is perfected.

Parts completely severed, and immediately replaced, will often, if judiciously managed, reunite, and be nearly, if not quite, as useful as before.   Numerous well-authenticated cases are upon record of bits of fingers, the nose, and the ear having been successfully treated in this wise.

It was upon a knowledge of the peculiar plastic properties of lymph that Tagliacozzio founded his world-renowned operation, now universally known by his name, of repairing mutilated noses, lips, and ears.   His attention was originally directed to the subject by watching the effects of the grafting of trees ; he observed that the transplanted portion not only contracted firm adhesions in its new situation, but that it generally grew with great vigor, and ere long produced most excellent fruit, altogether superior to, and different from, that of the parent stock.   Possessed of a profoundly inventive genius, he was led to believe that a similar operation might be performed upon man, and it was not long before he put his reasoning to the test of experiment.   His success was so complete that he became the great rhinoplastic surgeon of his day.   His method consisted, first, in raising a suitable flap of integument from the arm ; secondly, in thoroughly paring the mutilated organ ; and lastly, in sewing the raw edges accurately together, care being afterwards taken to put the parts in the closest relation until they were firmly and inseparably united.   The Indian method, as it is termed, differs from that of Tagliacozzio mainly in this, that the flap of skin is generally borrowed from the immediate vicinity of the deformed organ, its pedicle being twisted upon itself in such a manner as not to interfere injuriously with its circulation.

Some very curious experiments, illustrative of the surgical uses of this substance, were performed towards the middle of the last century by Du Hamel ; one of these experiments consisted in ingrafting the spur of a cock upon the comb of the same bird, where it speedily contracted adhesions, and gradually attained a large size.   Hunter, who repeated the experiments of the Dutch physiologist, went a step further, transplanting the

testis of a cock into the abdomen of a hen, where the union became so perfect that he could readily pass injecting matter from the vessels of the one into those of the other. The fact that a healthy tooth, extracted by mistake, will, if immediately replaced in its socket, speedily reunite, and ultimately regain its original hold, has long been familiar to dentists. Hunter found that if a fresh human tooth be inserted into the comb of a cock, it will soon become firmly fixed in its new situation, vessels extending up into the cavity of the fang, so as to establish an active circulation between the two bodies.

Curious and instructive as these experiments are, they hardly equal, in point of interest, many of those that have been performed by the modern surgeon upon the human subject for the relief of mutilated structures. One of the most recent additions to our knowledge is the transplantation of bits of skin for the cure of wounds and ulcers, suggested by Reverdin, and so successfully employed in numerous instances both in Europe and in this country.

The good effects of plasma are exhibited in various other processes, as in the suppression of hemorrhage, and the radical cure of hernia. In the former, the patient would inevitably bleed to death if it were not for the agency of this substance in sealing the mouth of the vessel by attaching the internal clot firmly to its surface. In hernia a radical cure can only be effected through the intervention of plastic matter, thrown out as a consequence either of the pressure of a well-adjusted truss, or of the injection of some irritating fluid, causing inflammatory action of the parts around.

Plastic matter is often useful in circumscribing morbid action, and in inclosing foreign bodies. In abscess a wall of this substance is generally formed around the pus, effectually preventing its diffusion among the surrounding tissues. Occasionally the fluid is inclosed by a distinct membrane, derived from the fibrin of the blood, and possessed of a high degree of organization. In carbuncle and erysipelas the matter is usually of an aplastic nature, and therefore unable to prevent the extension of the disease. Balls, needles, pins, and various other foreign bodies are occasionally surrounded by a cyst, and, in consequence, often remain harmless tenants of the body for many years.

Plasma may be of service in obviating accidents. Thus, in abscess of the lung, if it were not for the intervention of fibrin, the matter would often break into the chest, and rapidly destroy life. As the disease advances, the pulmonary pleura becomes inflamed and pours out lymph, which thus serves as a bond of union between this membrane and the costal pleura; so that by the time the matter reaches the surface an effectual barrier is opposed to its effusion, and the consequence is that it generally discharges itself through a contiguous bronchial tube. A similar occurrence takes place in abscess of the liver in relation to the peritoneum and the intestinal tube. In typhoid fever the glands of Peyer are often perforated, and yet the contents of the bowel seldom escape into the abdominal cavity, simply because, as the disease progresses, the contiguous serous structures are firmly glued together by plasma.

Finally, lymph is of use in obliterating serous cavities. In the radical cure of hydrocele, a disease of the vaginal tunic of the testicle, an operation is performed for the purpose of provoking a deposit of fibrin, barely sufficient to cover the opposing surfaces, and to insure their permanent agglutination. Serous cysts are treated upon similar principles; and modern surgery has been emboldened to inject even some of the movable joints, the abdomen, and ovarian tumors with irritating fluids, for the radical cure of dropsical diseases of these parts.

Injurious Effects of Plastic Matter.—Lymph is capable of producing injurious effects as well as beneficial; nature's operations cannot always be controlled by art, and it is, therefore, not surprising that she should often overleap the bounds of discretion when engaged in depleting inflamed structures by the effusion of plastic matter. Immense mischief is frequently done in this manner within a few hours after the commencement of the morbid action; mischief which it may require months of the most judicious and persevering efforts of the surgeon to eradicate.

Among the more common and obvious effects of this description are the following: 1. Mechanical obstruction of the natural outlets of the body. 2. Change of structure by interstitial deposits. 3. Abnormal adhesions. 4. Strangulation. 5. Loss of transparency. 6. Induration and enlargement.

a. An example of mechanical obstruction from a deposit of lymph is afforded by what occurs in the windpipe in plastic croup, the principal anatomical character of which is the formation of a false membrane, which often moulds itself accurately to the shape of the tube, and which, especially if it extend high up into the larynx, may cause suffocation by impeding the entrance of air into the lungs. In rare cases the membrane is detached

and expectorated; but generally it remains despite our remedies, and speedily destroys the patient, even tracheotomy seldom averting death.

In some of the mucous canals this matter is poured out beneath the lining membrane instead of upon its free surface, where, becoming organized, it leads to permanent contraction of the tube. It is in this manner that stricture is formed; when the case is a very bad one, lymph may also be effused into the substance of the lining membrane, and even upon its free surface, as, for example, in what is called the bridle-stricture of the urethra.

3. Change of structure from interstitial deposit of lymph occurs in almost all cases of inflammation, however slight or however situated. In pneumonitis, it closes up the air-cells and minute bronchial tubes, as well as the cells of the connective tissue, producing what is called hepatization of the lungs. Opacity of the cornea, acting obstructingly to the rays of light, is the invariable result of a deposit of plastic matter either beneath its conjunctival covering or in its interlamellar structure.

γ. All abnormal adhesions are effected by this substance, and are necessarily more or less prejudicial. In the thoracic cavity, they confine and restrain the movements of the heart and lungs; in the abdomen, they often become a source of internal strangulation; in the mucous outlets, as in the vagina and uterus, they may produce complete occlusion of their orifices; and in the vessels, especially the arteries, they have been known to induce obliteration of the largest trunks. Abnormal adhesions between the bowel and the sac in hernia are sometimes a cause of its irreducibility.

Great mischief is often done by the lymph that is effused within a joint. The matter, if not promptly removed by the absorbents, is organized and converted into an adventitious structure, which, undergoing various transformations, at length assumes the properties of the osseous tissue, and effectually destroys the motions of the articulation. The case, in fact, is one of bony ankylosis, which it is often difficult, if indeed not impossible, to cure.

δ. When this substance is arranged in the form of a cord or band, it may act as a compressing agent, by arresting the circulation, and thus give rise to all the symptoms of fatal obstruction. A band or cord of lymph, for example, extending from one organ to another, may as effectually strangulate the bowel as when the tube is girted by the rings of a hernia at one of the natural outlets of the abdomen. Dr. Montgomery, of Dublin, has shown that the amputations of the limbs which occasionally occur spontaneously during utero-gestation are due to the constriction caused by cords of this kind accidentally thrown around the affected member, and acting on the principle of a gradually tightened ligature. The constant tendency of such bands to contract affords a ready explanation of an event which, until recently, was universally regarded as a result of gangrene.

ε. Loss of transparency in structures that are naturally transparent, as the cornea, or translucent, as the serous membranes, is a common consequence of a deposit of plasma. This has been supposed by some to be due, in part at least, to a change in the nutrition of the affected tissues; but, in general, it will be found to depend solely upon the presence of inflammatory material.

ζ. Among the more frequent evils of plastic deposits are induration and enlargement, or hardening and thickening of the affected organs and tissues. Such occurrences are generally exceedingly annoying, often severely taxing the patience of the sufferer and the skill of the professional attendant. They are the direct result of interstitial effusions, which often manifest an early tendency to organization and transformation, and which none but the most determined perseverance in the use of remedies can ultimately overcome. The stiff and thickened joint, the indurated and enlarged testicle, the hypertrophied spleen, liver, and lymphatic gland, the hardened and enlarged tonsil, so frequently seen in practice, are sad illustrations of the truth of this statement.

When lymph is effused upon an open surface, as a wound or an ulcer, its appearance may generally be taken as a true index of the precise character of the action that is going on in the affected part, as to whether that action is healthy or unhealthy; and it is, therefore, capable of affording valuable therapeutic indications. When it has the requisite degree of vitality, it is promptly converted into healthy granulations and new tissue; whereas, when the reverse is the case, it rapidly perishes, and is finally thrown off as an effete substance or as a species of slough, the surface beneath exhibiting an irritable, inflamed, phagedenic, or gangrenous aspect, and discharging a thin, serous, or bloody fluid, more or less fetid, and entirely destitute of the properties of laudable pus. This local action of the part is generally associated with a depraved, vitiated, scorbutic, or typhoid state of the system, and is liable to run into the very worst forms of pyemia and erysipelas, especially during the prevalence of epidemics, among the inmates of crowded, ill-venti-

lated hospitals, and other establishments for the accommodation of the sick and wounded. Under such circumstances the lymph is nearly always aplastic, so much so, indeed, that the patient may be said to be laboring under a veritable aplastic diathesis.

TREATMENT.—The treatment of lymphization is conducted upon general antiphlogistic principles ; undue action is repressed, and the absorption of effused matter promoted. To accomplish the first of these objects, the ordinary local and constitutional measures are employed ; for the second, sorbefacients are necessary, as mercury and iodide of potassium internally, and the tincture of iodine, liniments, and embrocations externally. In the acute stage of the disease, while secretion is still active, purgatives and antimonials, with the judicious exhibition of calomel, constitute the chief means of relief ; but, the tendency to deposit having ceased, their use is dispensed with, all except the mercury, which is now given in minute doses, and with a view strictly to its alterative effect ; it is often carried to slight ptyalism, the mouth and gums being maintained in a tender condition for, perhaps, several weeks consecutively ; or, with an occasional interval, for even a much longer period. In the latter event, the bichloride frequently, if not generally, forms a valuable substitute for the calomel ; less likely to act hurtfully, and yet, at the same time, very effectually stimulating the absorbents. In such cases, too, small doses of tartar emetic often produce a most salutary influence, its action being hardly inferior to that of mercury itself, with which it may frequently be advantageously combined. When the inflammation has measurably subsided, its products, especially the serous and plastic, are generally easily disposed of by chloride of ammonium, or iodide of potassium, administered in doses varying from three to twenty grains, thrice in the twenty-four hours ; strict attention being meanwhile paid to the diet and bowels. When the case is obstinate, an occasional mercurial constitutes a valuable addition.

Among the more beneficial topical means are, the dilute tincture of iodine, applied twice in the twenty-four hours ; inunctions with mercurial and other unguents, particularly t .at of the iodide of lead ; stimulating embrocations ; and steady, uniform support with the bandage. Various kinds of plasters, as the common mercurial, the compound galbanum, and others of a kindred nature, are also frequently serviceable. Washing the part well, when accessible, twice a day with hot water and Castile soap, followed by dry friction, often does more good than anything else. In some cases, again, cold, especially in the form of the douche, acts very beneficially, affording relief when other treatment fails. In the joints passive motion must be carefully performed, at first once, and then twice a day, to prevent ankylosis from the organization of the fibrinous bands which are so liable to form during the progress of synovitis.

When the object is simply to assist nature in her efforts to repair an injury, as a wound or fracture, care should be taken, on the one hand, that the attendant action is not too low, and, on the other, that it does not transcend the fibrinizing limits. By overofficiousness the system may be so exhausted as to render it impossible for the part to furnish an adequate amount of lymph, and a similar condition is often induced by debility, the result of previous disease, intemperance, or imperfect nutrition from want of proper food. Whatever the cause may be, it should be promptly counteracted by the use of tonics, especially quinine and iron, alcoholic stimulants, and other invigorating measures, to supply the blood with the requisite material for the deposition of fibrin ; all enfeebling topical applications being at the same time discontinued. Overaction, on the contrary, is met by the usual antiphlogistic means, carefully and warily applied, lest harm should arise from the too rapid reduction of the vital powers. The management of the reparative process always demands great judgment and vigilance.

SECT. IV.—SUPPURATION AND ABSCESS.

Suppuration, the process by which pus is formed, is one of the most frequent, as it certainly is one of the most important, of the results, events, or conditions of inflammation. Its presence, as a rule, is denotive of a higher grade of excitement than a mere deposition of serum and plastic matter, which, however, are nearly always associated with it. But it must not be supposed that the reverse of this proposition is true ; for inflammation often exists in a severe degree, with an abundant effusion of the watery and fibrinous elements of the blood, and yet there is not the slightest evidence of suppuration.

It was formerly supposed that suppuration might occur independently of inflammation, an opinion which, doubtless, had its origin in the fact that there are occasionally cases in

which large quantities of pus are thrown off, without any evidence of the ordinary phenomena of inflammation, such, especially, as pain, heat, and discoloration of the structures in which the matter is formed, or any constitutional disorder ; the whole process being apparently conducted as if both the part and system were unconscious of what is going on.   Such cases are by no means infrequent, and yet, if they be carefully investigated, or traced through the various stages of their progress up to the dissection of the affected tissues, the most satisfactory proof will be afforded of their phlogistic nature.   In a cold, strumous, or scrofulous abscess, for example, which has so often served as the basis for this now exploded idea, and the formation of which is sometimes the work of several months, inflammation is just as much concerned in the production of its contents, as in a phlegmonous boil that is developed in three or four days.   The only difference is that in the one the morbid process advances very slowly, indeed almost imperceptibly, while in the other it proceeds very rapidly, and is accompanied by such well-marked symptoms as to render it impossible to mistake their character.

Matter may form without any breach of continuity of the affected parts.   This mode of suppuration is, in fact, very common, not only in the serous cavities, but throughout the greater portion of the mucous system.   It is not, however, confined to these textures.   In the connective tissue, lungs, brain, liver, and other viscera, nothing is more frequent than suppuration without any ulceration whatever in the incipient stages of the morbid action.

Suppuration does not take place equally readily in all the organs and textures.   Of the viscera, those most prone to it are the liver, lungs, and brain ; of the tissues, the connective, cutaneous, mucous, and serous.   In the fibrous, cartilaginous, tendinous, and osseous textures, pus not only forms with difficulty, but is seldom of a thick, consistent character.   Of the mucous system some portions are more liable to suppuration than others.   Thus, it is much more common in the colon than in the stomach or ileum, in the vagina than in the uterus, in the urethra than in the urinary bladder, in the nose than in the mouth, in the fauces than in the œsophagus, in the bronchia than in the larynx.   So, likewise, in the serous system, suppuration is more frequent in some situations than in others, as for example, in the pleura, the vaginal tunic of the testicle, and the lining membrane of the larger joints.   In the subcutaneous connective tissue, pus forms most rapidly in parts remote from the heart.   The bloodvessels do not often suppurate, except when wounded ; and the same, so far as can be ascertained, is the case with the absorbents.   The lymphatic glands, however, suffer very frequently, especially those of the axilla, groin, neck, and base of the lower jaw, particularly in persons of a scrofulous taint.   Nervous tissue seldom suppurates ; muscular still more rarely.   From all these facts we may deduce the axiom that those structures are most prone to form matter which contain the largest amount of loose connective substance, and, conversely, that those which possess this tissue sparingly always suppurate with difficulty, requiring, generally, a much longer period, and elaborating a less perfect fluid.

The period at which suppuration occurs after the establishment of inflammation varies, on an average, from twenty-four hours to three or four days, depending upon the nature and situation of the affected tissues, the intensity of the morbid action, and also, in a very material manner, upon the condition of the system, and the character of the exciting cause.   Mucous membranes, especially if exposed to the air, generally suppurate very readily, having, seemingly, a predisposition to take on this kind of action ; serous membranes, on the contrary, as they are arranged in the form of shut sacs, do not feel the stimulus of the atmosphere, and, therefore, suppurate with difficulty ; another reason, doubtless, is the fact that such structures, when irritated, are naturally inclined to furnish lymph rather than pus, their organization peculiarly fitting them for that office.   The same difference exists between the veins and arteries, and it is practically fortunate that it does ; otherwise the danger of wounds, whether the result of accident or design, requiring ligation of the principal arteries, would be much greater than it is.   In some of the internal viscera, as the brain and liver, pus occasionally forms with great rapidity, as is seen in cases of injuries of these organs.   Matter, other things being equal, forms most readily when the inflammation is very intense.   A wound in an unhealthy or intemperate person is more likely to run speedily into suppuration than a similar one in an individual of sound constitution and regular habits.   A phlegmonous boil usually pours out pus in from twenty-four to thirty-six hours, whereas a chancroid does not furnish any until about the beginning of the fourth day.   In variola, the suppurative process is seldom fully established before the ninth day.

Exposure of an inflamed surface to the air greatly promotes suppurative action, and

is, therefore, directly hostile to adhesion. The more nicely the edges of a wound are approximated, the greater, other things being equal, will be the probability of speedy and permanent reunion, and conversely. Serous membranes, as already stated, have naturally a disposition, when inflamed, to pour out lymph, and to contract adhesions; but whenever they lose the character of closed sacs, as they necessarily do when they are accidentally opened, the morbid action, consequent upon the injury, is certain to be followed by the formation of pus, especially if the air have free access to them for any length of time.

When suppuration is fully established, it is impossible to predict when it may terminate. In many situations, as, for example, the bowels and the bronchial tubes, it occasionally lasts for years, the discharge literally usurping the place of the natural secretions.

Suppuration, when very profuse, as in a lacerated wound, an inflamed joint, or a large, irritable ulcer, leads to rapid exhaustion by the abstraction of the more important elements of the blood, and by the induction of hectic fever, pyemia, or purulent infection, generally attended by severe rigors and copious sweats, rapidly draining the system. The appearance of thick, yellow, cream-like pus, under such circumstances, is always hailed by the surgeon as a gratifying omen, indicating, as it does, a decided improvement both in the part and system. Pus serves as a protective to granulating surfaces, preserving moisture and promoting growth; assists in detaching foreign bodies impacted in the soft structures and is probably instrumental, at least at times, in eliminating noxious matter from the blood, or so changing its character as to render it harmless.

Pus, the product of suppuration, originally appears in the form of distinct globules, dispersed through the affected structures, where they may be easily recognized by their pale yellowish color. As the particles increase in number, they gradually become confluent by the removal of the diseased tissues, the matter being thus collected into an abscess.

The symptoms which characterize the suppurative process will claim special attention under the head of abscesses. Here it will suffice to observe, in general terms, that they are such as denote the existence of ordinary inflammation, with an increase, more or less considerable, of the local and constitutional disturbance.

Pure pus, such, for example, as is found in a well-matured phlegmonous abscess, is an opaque, homogeneous fluid, of a yellowish-white color verging on greenish, of a sweetish taste, without any particular odor, of a cream-like consistence, slightly viscid, and of an average specific gravity of 1030 to 1033. It has a faint alkaline reaction, is imperfectly soluble in water, does not readily putrefy, and is coagulated by heat, acids, and chloride of ammonium. Freezing destroys its normal properties.

The specific gravity of pus is liable to considerable variation, depending mainly upon the quantity of its solid ingredients and the density of the pus-liquor. Thus, in seven examinations of this fluid, taken from abscesses in different situations—as the thigh, arm, axilla, back, pleura, and the lung in pulmonary phthisis—Dr. John Davy found the specific gravity as low in one as 1021, and in another as high as 1042.

Pus essentially consists of the elements of the blood, in an altered state, water constituting about eighty-five per cent., the remainder being made up of albumen, fatty matter, osmazone, and salts, as chloride of sodium, and phosphate of calcium and magnesium. Lehmann, who has carefully examined this fluid, found the quantity of fatty matter to vary from 2 to 6 per cent., and the quantity of albumen in the serum from 1–2 to 3–7 per cent. Casein and hematin do not exist in normal pus. A peculiar principle, termed pyine, has been detected in it by Güterbock, supposed by some to be an oxide of protein, by others a form of fibrin. It is soluble in water, but insoluble in alcohol. Recent examinations have shown myosin, paraglobulin, protozen, leucin, and tyrosin to be constant constituents. Pyocyanine, the substance which imparts the bluish or greenish color to the contents of certain abscesses, and to the discharges of certain ulcers, is occasionally present. Pus of an orange color is sometimes met with, but all attempts to trace its origin, or to decipher its significance, have thus far failed.

Pus is composed of numerous corpuscles, suspended in a thin, transparent fluid, called pus-liquor. These little bodies, known as pus corpuscles, are spherical, finely granular masses of germinal matter or protoplasm from the $\frac{1}{2000}$ to the $\frac{1}{3000}$ of an inch in diameter, and identical with lymph and colorless blood corpuscles. They are not vesicular in structure, for what was formerly considered to be a distinct cell-wall, is now known to be simply a peripheral, limiting layer of non-germinal or formed material. They are provided with nuclei, which are rendered visible on the addition of water or acetic acid, and are deeply stained by ammoniacal solutions of carmine. Some contain one well defined nucleus, others two, three, or more small nuclear bodies, their size depending upon

their number.   Fig. 13, from Rindfleisch, exhibits pus corpuscles in their different forms :
a represents globules containing a single, large nucleus, from the pus of a healthy, granu-
lating sore ; at *b* and *c* are seen cells from an abscess, before
and after the action of acetic acid ; broken-down globules,
from the pus of carious bone, are delineated at *d* ; while at
e are shown the forms which the living cells assume, by vir-
tue of their softness and elasticity, in their amœboid move-
ments.

Fig. 13.

Various Appearances of Pus
Corpuscles.

The pus corpuscles float in the pus-liquor, and are inter-
mixed with various solid elements, as granules, shreds of
fibrin, epithelial matter, and also, at times, with small
homogeneous, non-nucleated corpuscles, termed pyoid.

Pus is liable to be modified in its properties by the pres-
ence of extraneous substances, as grumous blood, fibrin,
cholesterine, and the debris of the organs and textures in which it is formed.   In com-
mon phlegmon, it often contains shreds of connective tissue, of a dirty grayish color, not
unlike wet tow.   The brownish matter found in certain abscesses of the liver probably
derives its color and consistence from the intermixture of softened, disintegrated, hepatic
parenchyma.   In suppuration of the different glands, the pus is not unfrequently mingled
with the product of their peculiar secretions, as urine in the kidney, bile in the liver,
milk in the mamma, and semen in the testis.   Purulent matter is sometimes very fetid,
apparently from the extrication of sulphuretted hydrogen.

The different varieties of pus have received different names.   When the fluid is of a
whitish, or pale yellowish color, creamy in consistence, and composed of numerous globules,
it is said to be *healthy*, pure, or laudable, in reference to the process by which it is pro-
duced, this being of a healthy, sanative, or restorative nature.   It is usually met with in
suppurating wounds, in healing ulcers, and in phlegmonous abscesses.

Sanious, serous, ichorous, or sanguinolent pus is thin, almost transparent, of a yellowish,
amber, or reddish color, and generally so acrid as to erode the parts with which it comes
in contact.   It is a product of unhealthy inflammation, and is principally observed in caries
of the bones, irritable ulcers, and open carcinoma.   This variety of pus is often intermixed
with grumous blood, flakes of fibrin, and the debris of the affected tissues.   The thin, sani-
ous pus furnished in abscess, ulceration, and necrosis of the osseous tissue, not unfrequently
contains a considerable quantity of phosphate of lime.

Fibrinous pus consists of common pus in combination with plasma.   It is of a whitish,
grayish, or cineritious color, and of a semiliquid, concrete, or lardaceous consistence.
Under the microscope, it displays the globules of healthy pus, with numerous other cells
and fibres, of irregular shape.   It is usually found in the joints, in the splanchnic cavities,
in metastatic abscesses, and in carbuncular inflammation.   Its presence denotes a high
degree of morbid action.

Scrofulous pus is chiefly met with in pulmonary caverns, cold abscesses, scrofulous dis-
ease of the joints, and chronic inflammation of the lymphatic glands.   After standing a
while, it usually separates into two parts, of which one is thick, straw-colored, and inodor-
ous ; the other, which rests on the surface, is oily in appearance, thin, ropy, and mixed
with small, opaque, curdy flakes.   When scrofulous pus is long retained, it may acquire a
disagreeable, nauseous smell, not unlike the pollen of the chestnut ; at other times it is
excessively fetid.   The attendant action is usually very languid.   The term curdy is often
applied to this variety of pus.

Gummy pus, as it is termed, is a product of syphilitic affections of the bones, muscles,
connective tissue, and internal organs.   In its appearance it bears a strong resemblance
to a thin solution of isinglass, arrowroot, or gum arabic, is of a pale whitish color, more
or less ropy in consistence, and in great degree destitute of the properties of ordinary pus.
It is composed mainly of albumen, and contains only a few well-formed pus corpuscles :
oil globules and fatty matter are usually present in it.

There is a variety of pus to which, from its admixture with mucus, the term *muco-pu-*
rulent is applied.   It is usually a product of a high degree of inflammation of the various
outlets of the body, particularly of the nose, eye, bronchial tubes, and genito-urinary
apparatus.   The mucus supplied by these surfaces in the healthy state is composed of a
transparent fluid, and of abraded epithelial cells, flat, and irregularly sided, with a central
nucleus.   In addition to these, the microscope detects numerous granular masses and
spherical globules, similar to those of pus, suspended in a viscid, transparent, ductile fluid.
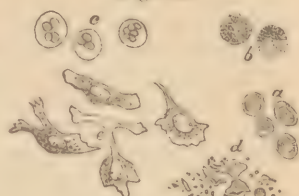
Under inflammation, the epithelial cells are cast off so quickly that they do not have time to be flattened out, and the globules are not only greatly augmented in number, but they acquire somewhat the character of those of pus.

Finally, what is called *puriform* matter, is, as the name implies, not genuine pus, but an imperfect liquid bearing some resemblance to it. It occurs chiefly in bad forms of inflammation, as erysipelas, carbuncle, and pyemia, and consists essentially of broken-down lymph and shreds of tissue, interspersed with fatty substance, granules, abortive cells, and a few globules, smaller than those of pus, and not affording the usual reaction under acetic acid. The puriform matter, so abundantly thrown off in inflammation of the serous membranes, is generally nothing but turbid serum.

Certain kinds of pus, as those, for example, of smallpox, varioloid, farcinia, gonorrhœa, and venereal ulcers, are *contagious*. In what particular element of the fluid the virus or specific secretion is contained, or whether it exists as an entity, is undetermined. The vitality of the organ by which it is elaborated is not necessary for the preservation of its peculiar effects. Once formed, it becomes independent of its source, and retains, for a considerable period, the power of contaminating the parts to which it is applied, producing a disease of the same character. Various chemical reagents, however, as the alkalies and acids, effectually neutralize, if they do not completely destroy, its specific properties. The pus of a chancroid often contains animalcules, particularly the vibrio lineola.

Pus is a substance that is easily altered in its properties, the causes which mainly contribute to this result being its age, or the length of time during which it is retained in the body, and the contact of various fluids, especially air, gas, and water. The globules of the pus of an old abscess always contain fine fatty granules, generally from five to ten in number, which, when the development is unusually perfect, present a large, swollen appearance. The caseous transformation is observed chiefly in old scrofulous abscesses, the pus-liquor of which is absorbed, while the pus globules, assuming an angular configuration, shrink, atrophy, and form, by their agglomeration, a dryish caseous mass, of a whitish or slightly yellowish color. In abscesses of the cancellous structure of the bones, especially in those communicating with the joints, the fluid is generally very thin and watery, and not unfrequently contains lactic acid, under the influence of which the pus cells are distended, the protoplasm dissolved, and the nuclei set free. In suppuration of the joints of the fingers in gouty persons the fluid usually contains a large quantity of urate of soda. The pus globules always experience great alterations in their size and shape when pus contains an unusual quantity of water. The presence of gas in pus has a tendency to decompose it, to render it fetid, and to change its color. Pigmentary infiltration of the pus globules occurs whenever the suppuration is attended with any considerable effusion of blood.

The distinction between pus and mucus is of practical importance. The microscope is the most certain means of discrimination; but, in its absence, other measures may be resorted to. Pus sinks in water; mucus floats. A glairy, viscid, gelatinous mass is formed by the addition to pus of about half its quantity of the officinal solution of potassa, no such effect resulting from the action of the alkali on mucus, which becomes more fluid and limpid. The serum of pus is highly albuminous; mucus is not. Mucus treated with acetic acid coagulates into a thin, membranous substance; pus does not. Under the application of ether, mucus yields the merest trace of fat, while pus always furnishes this material in considerable quantity. Pus diffused through blood can only be satisfactorily detected with the microscope, but in many cases the examination is very difficult on account of the very close resemblance of the globules of the two fluids to one another.

The differences between pus and milk, as in mammary abscesses, are generally easily distinguished by the relative size of the globules, those of the former being a good deal larger than those of the latter fluid. Purulent urine always contains albumen, and exhibits the characteristic pus globules. Softened and broken-down fibrin, as in clots in the bloodvessels, connective tissue, old aneurisms, and the splanchnic cavities, sometimes bears a considerable resemblance to pus, but differs from it in being destitute of exudation cells. Softened atheromatous matter is distinguished by the presence of cholesterine and the absence of pus corpuscles.

By far the most ready, delicate, and trustworthy differential test of pus, however, is the color test, discovered by Dr. John Day, of Victoria. It is founded on the property possessed by oxygenated tincture of guaiacum of turning a clear blue color when brought in contact with pus, no such effect being produced on mucus, except on the addition of carbolic acid diluted with alcohol.

Pus was formerly supposed to be a product of broken-down fibrin; but the observations of Virchow, Cohnheim, and other German pathologists, show that pyogenesis is due to the disturbances of the circulation and nutrition of the affected structures, through which the activity of local protoplasmic masses is increased, as evinced by their enormous multiplication. It has been demonstrated by Virchow that, under the influence of the assimilation of an excess of blood-liquor, which has escaped from the dilated vessels at the focus of the inflammation, the connective-tissue corpuscles proliferate and assume the characters of pus globules. This theory of the formation of pus, however, is too exclusive, and has been placed in doubt by the discovery of Cohnheim, who has shown by a series of well-contrived experiments that pus is in a great degree the product of the colorless blood corpuscles, which have wandered out of the vessels into the tissues. The results of these experiments have been confirmed by the researches of Koster, Vulpian, and other observers, and they carry the mind back to the days of Gendrin, who, in 1824, in his great work on the Anatomical History of Inflammation, enunciated almost precisely similar views, based upon his own investigations. It has, moreover, been demonstrated that other cell elements enter into the formation of pus, as, for example, those of the cornea, muscles, glands, mucous and serous membranes, which by their germination aid in the process. These points have been fully discussed in studying the intimate nature of inflammation, and need only be thus briefly referred to here. They, however, clearly point to the fact that pus is a fluid inflammatory new formation, due to the accumulation of young cells, which are derived partly from the blood, and partly from the cell elements normal to the tissue or organ affected.

Pus corpuscles are originally alive, and in a state of active amoeboid movement, proliferating and sending out offshoots which form new corpuscles. Their transition from lymph and blood corpuscles may in many cases be distinctly traced with the aid of a magnifying glass; but how, or in what manner, they obtain their peculiar color and other physical properties, is undetermined. The probability is that the process is partly of a vital, partly of a chemical nature. All that is certainly known is that the pus corpuscles, in their size, shape, and structure, closely resemble lymph or colorless blood corpuscles, and that the fluid in which they are suspended always contains more or less oily matter, which, formed during their metamorphosis, constitutes one of its characteristic attributes.

Pus is susceptible of absorption, probably in all its varieties, as well as in almost every locality. Of this fact satisfactory proof is afforded by what occurs in abscesses in the different external parts of the body; and it is, therefore, analogically reasonable to infer that it may also take place in the internal organs and cavities. Great doubt has been expressed by some pathologists respecting the possibility of pus being taken up in this manner, on the ground, chiefly, that the accumulations which occasionally disappear, both spontaneously and under treatment, are really not abscesses, but collections of plastic matter. Every surgeon of experience, however, knows that pus, or puriform fluid, is sometimes removed by the agency of the absorbents, after its existence has been satisfactorily tested by the exploring needle. Particular remedies are often employed for the attainment of this object, and our efforts are certainly not unfrequently crowned with success, although probably not so often as is generally supposed.

When pus disappears spontaneously, it is highly probable that the more fluid elements enter the system readily, and without any previous change; indeed, recent observation has shown that even the pus corpuscles may do this, although it is reasonable to suppose that, as a rule, the absorbent vessels do not admit them unless they have been more or less disintegrated and broken down. Whether the fatty matter remains, or whether it, also, is removed, has not been determined. How pus is disposed of, after it has reached the circulation, is likewise unknown; the most reasonable conclusion is that it undergoes oxidation, and that it is excreted by the liver and kidneys, if not, also, by some of the other emunctories.

ABSCESSES.

An abscess is a circumscribed cavity of abnormal formation, containing pus. When the matter is poured into a natural cavity, as the chest, or into a joint, the collection constitutes what is called a purulent effusion. An abscess may be superficial or deep, acute or chronic, common or specific. It is said to be superficial when it lies immediately beneath the common integuments or in the connective tissue among the superficial muscles. The word deep, on the contrary, is used when the matter is lodged in an internal organ,

in a bone, or among muscles. The terms acute and chronic have reference merely to the time occupied in the formation of the abscess. A common abscess is one produced by ordinary inflammation; while the specific abscess is the result of the operation of some particular poison, as the virus of chancroid, smallpox, or glanders. Finally, an abscess is circumscribed, as when it is bounded by plastic matter; or diffused, as when its contents are sent abroad through the connective tissue.

The most natural division of abscesses is into phlegmonous, scrofulous and metastatic, the first being incident to all persons, while the second occurs only in certain classes of individuals, or such as are affected with a strumous taint of the system. The term "metastatic," formerly so much in vogue, is employed to designate those collections of pus which supervene upon severe injuries, operations, and diseases, and might advantageously be abolished, as it is calculated to convey false impressions respecting a form of suppuration which properly comes within the definition of phlegmonous, although, as will be shown by and by, it is generally supposed to have its origin in a septic condition of the blood. It has also been described under the term "multiple," and will claim particular attention under the head of pyemia. It is not easy, in the present state of the science, to assign an appropriate place to the diffuse abscess, as it is often impossible to determine its true character. The specific abscess does not require any special consideration, since, apart from its exciting cause, its mode of formation does not, so far as we are able to comprehend it, differ at all from that of the common phlegmonous abscesses.

Sir James Paget, in 1869, described what he calls the "residual abscess," formed out of the debris of former structures of this kind, often at the distance of many years, from a recurrence of inflammation, especially after the system has become exhausted by the influence of disease or accident. The occurrence is most common in connection with scrofulous abscesses, the walls of which, left in an unsound condition, are very susceptible to fresh attacks of inflammation, the predisposition to disease being augmented, often very greatly, by the retained, withered, half dry, and degenerated pus. Instead of calling such abscesses residual, it would be more appropriate to denominate them "recurrent," as the name is more expressive of their peculiar character.

1. PHLEGMONOUS ABSCESS.

A phlegmonous abscess is one which, running its course with unusual rapidity, is always accompanied by well-marked inflammatory symptoms. The part feels, as the name implies, as if it were on fire, being hot, tender, and exquisitely painful. A tensive, throbbing sensation is usually present, synchronous with the pulse at the wrist, and greatly aggravated by dependent position; it is particularly severe at the focus of the morbid action, and is a valuable diagnostic symptom, as it is generally denotive of suppuration. Its immediate cause, as explained elsewhere, is obstructed circulation, with consequent pressure upon the nerves of the affected structures.

The mode of development of a phlegmonous abscess is an interesting study. In the first place, the matter is obliged to have a receptacle for its accommodation. This is usually furnished by the cells of the connective or areolar tissue of the part; but as the accumulation, at first drop-like, progresses, this substance is destroyed by ulcerative action, or by the action of the absorbents, and a cavity is thus gradually formed, often capable, in the end, of holding an immense quantity of fluid. While the process of deposition is going on, plastic matter is poured out at the periphery of the cavity, gluing up the connective tissue, and thereby forming a kind of boundary line around the pus, which effectually prevents its diffusion among the surrounding structures. No distinct cyst is constructed, for nature has not time for such an enterprise, nor is she at all in need of it, although the occurrence is not impossible even in acute abscesses, especially in one of the liver. The next phenomenon to be observed is the effort which the matter makes to reach the nearest surface, for this is one of the laws of interstitial suppuration. To this end the matter itself is eminently contributary, the pressure which it exerts upon the superimposed parts greatly promoting and expediting the ulcerative action, by the agency of which evacuation is finally attained. Thus, at least three separate and distinct processes are going on during the formation of an abscess; a deposit of pus, an effusion of plasma, and ulcerative absorption. The importance of an effusion of plasma is shown by the fact that, when this substance fails to be poured out, the contents of the abscess are widely diffused among the surrounding structures, committing extensive havoc in the connective tissues, and causing frightful separation of the muscles. These evil effects are often witnessed

in phlegmonous erysipelas, where, from the cacoplastic character of the lymph, the matter occasionally burrows to a great distance, destroying everything within its reach.

The great law which presides over the spontaneous evacuation of abscesses, by which their contents are enabled to reach the nearest surface, is attended with the most fortunate results, for it not only abridges suffering, but saves structure. Thus, in abscess of the liver, a long time would elapse, and an immense amount of pain and constitutional disorder would be caused, if the matter, instead of emptying itself, as it usually does, into an adjoining coil of intestine, were compelled to travel across the walls of the abdomen.

The contents of the phlegmonous abscess usually partake strongly of the nature of well-elaborated pus, being of a whitish, or pale straw color, and of a thick, cream-like consistence, with an abundance of large and well-matured pus corpuscles. Intermixed with them are often flakes of lymph, and the debris of the affected structures. Thus, in abscess of the external parts of the body, it is not uncommon to meet with shreds of connective tissue; in abscess of the liver, with broken-down hepatic substance. Occasionally, again, the pus is blended with the peculiar secretion of the part, as semen in abscess of the testicle, bile in that of the liver, and milk in abscess of the mamma. As a means of diagnosis, a knowledge of these facts is of great practical value, the nature of the adventitious matter often pointing directly to the seat of the disease. Some forms of acute abscess, as those more particularly which follow upon severe accidents and capital operations, and to which the term metastatic is sometimes applied, are made up almost entirely of fibrinous matter, the quantity of pus corpuscles being extremely small. When pus is long retained, the corpuscles may degenerate, breaking down and assuming an amorphous form; while the serum undergoes various chemical changes, often of a putrefactive character, attended, in most cases, with the fatty transformation, and sometimes even with the liberation of calcareous salts.

The contents of certain abscesses are excessively fetid. This is especially true of abscesses around the anus, from the proximity of the pus to the bowel, or from the actual intermixture of fecal matter. The same circumstance occasionally obtains, although generally in a less degree, in abscesses in some other situations, as the tonsils, bones, and lymphatic glands.

An abscess sometimes contains air, the fluid resting upon the top of the matter, as in inflammation of the perineum, about the sacrum, in the ileo-lumbar region, and in front of the abdomen, from a communication with the intestinal tube. A similar occurrence is occasionally witnessed in suppuration of the chest, when the matter contained in that cavity makes an effort to escape externally through one of the intercostal spaces, after an opening has been made into a bronchial tube. In general, the pus, when thus admixed, is excessively fetid, and the abscess is distinctly emphysematous, crepitating under pressure, and often emitting a peculiar gurgling noise.

Phlegmonous abscesses occur at all periods of life, as well as in all classes of individuals. They are occasionally observed within a few weeks after birth, especially in the mamma and in the lymphatic glands of the neck and of the axilla. They may be traumatic, or idiopathic; or, in other words, dependent upon external injury, or constitutional causes, as a depraved condition of the blood, derangement of the digestive organs, or the suppression of some important secretion, as that of the liver, kidney, or uterus. Abscesses of this kind are sometimes of a secondary character, one forming after another, as if there existed a species of pyogenic diathesis. Such an occurrence often proves exceedingly untoward, sadly interfering with recovery, especially during convalescence after protracted fevers and severe injuries.

Although phlegmonous abscesses may form in any part of the body, they are most common in the connective tissue beneath the skin, among the muscles, and around the lymphatic glands, as well as in the substance of these bodies, especially in those of the neck, axilla, and groin. Among the internal organs, those that are most liable to suffer are the liver, lungs, and brain, but even here phlegmonous abscesses, except as a result of external injury, are extremely rare.

The number of abscesses varies from one to a great many, and is generally in an inverse ratio to their size. Two or three large ones occasionally exist simultaneously in different parts of the body; and, on the other hand, the whole surface is sometimes, as in variola, literally covered with small ones. The size of a phlegmonous abscess ranges from that of a mustard-seed up to that of an adult's head.

The symptoms which precede and accompany the formation of a phlegmonous abscess are very variable. In general, they are such as characterize ordinary inflammation. The

part, if open to inspection, is found to be red, hot, swollen, and painful, beating and throbbing synchronously with the left ventricle of the heart. As the matter accumulates, all these symptoms augment in severity, especially if the fluid is bound down by hard, unyielding structures, interfering with its exit or extension. Under opposite circumstances, however, the pain often diminishes, the part feeling relieved almost as soon as the deposition of pus has fairly begun. However this may be, the discoloration of the skin always increases as the matter approaches the surface, and generally assumes a dusky, purple, or livid aspect, particularly at the focus of the abscess. The swelling also augments, and the part often pits on pressure, more or less serum being effused into the subcutaneous connective tissue. The heat is much greater than it is in the surrounding structures, and there is always serious functional disorder.

The morbid action continuing, the centre of the abscess becomes acuminated, and the matter, in surgical language, is said to point. The skin here is not only greatly discolored, but thin and impoverished; and giving way at the most prominent part of the tumor, allows its contents to escape, generally by a small orifice, which is often entirely inadequate to thorough clearance. The period which intervenes between the commencement of the inflammation that leads to the formation of the abscess, and the evacuation of the pus, varies from a few days to several weeks.

When the abscess is small, or situated in a comparatively unimportant part, the constitution may fail to take cognizance of it, but this is the exception rather than the rule; for, in the majority of cases, the system warmly sympathizes with the local trouble, and manifests the interest it feels in it by well-marked inflammatory symptoms. When an abscess is about to form in an internal organ, the patient is seized with rigors, often violent and long continued, alternating with flushes of heat, and generally followed by copious sweats. This frequently happens even when the abscess is of a very trivial size; the importance of the affected structures giving proportionate force to the morbid action. Rigors also generally occur in abscess of the bones and joints, but comparatively seldom when the disease is seated in the subcutaneous connective tissue. An abscess of the ear, parotid gland, tonsil, anus, and perineum is nearly always attended with high constitutional excitement, along with cold, chilly sensations, and what are called muscular pains. If the case is at all severe, delirium will be likely to be present, lasting either until the part is relieved, or until the disease proves fatal. The countenance is generally flushed, the eyes are suffused, and there is often a hectic spot upon the cheek, especially in internal suppuration. The pulse is full, strong, and frequent; the skin hot and dry; the urine scanty, high-colored, and loaded with uric acid. Great thirst and restlessness usually exist. When the abscess is fully formed, the constitutional symptoms, as well, indeed, as the local, often greatly abate, comparative comfort succeeding the violent perturbation. The pulse becomes soft and calm, the surface is bathed with perspiration, the renal secretion increases in quantity and improves in quality, and the patient, grateful for the happy change, falls into a tranquil sleep.

Diagnosis.—Notwithstanding that the symptoms of phlegmonous abscess are usually well marked, cases now and then arise where the diagnosis is so obscure as to cause serious doubt respecting their true character. Indeed, there is probably no department of surgery where so many mistakes are constantly committed as in this. If the records of the science could be thoroughly explored, they would be found to abound in blunders of this kind. As it is, we frequently hear of carcinomatous and sarcomatous tumors, aneurisms, and hernias being opened for abscesses, and life either instantly destroyed, or placed in great ultimate jeopardy, by the operation. Such mistakes, which are more frequent in chronic than in acute abscess, are hardly less injurious to the surgeon than to the poor patient; for they but too certainly ruin his prospects and reputation as a practitioner. Attention to the following circumstances will materially assist in clearing up difficulty: 1. The history of the case; 2. Pointing; 3. Fluctuation; 4. Œdema; 5. The use of the exploring needle.

1. The first object that should claim attention is the *history* of the case. Upon inquiry, it will usually be found that the disease has been of short duration; having commenced with the ordinary symptoms of inflammation, and gradually increased until the suppurative point was attained, the fever being high, and the local distress often extreme. Rigors are looked for if the abscess be deep seated, extensive, or among important structures. The pain is tensive and throbbing, steady and persistent, not intermittent, or severe at one time, and absent at another. The countenance is expressive of great suffering, and, with a surgeon of experience, this symptom alone is sometimes sufficient to establish the diag-

nosis of the case. If the abscess is lodged externally, the swelling is observed to be gravescent, unnaturally hot, excessively tender, intolerant of manipulation, and of a dusky reddish color, especially at its most prominent point. Its career is comparatively brief, a few days, a week, or, at most, a fortnight, sufficing to reach its acme. Then comes the period of dissidence, if the matter is not evacuated; the symptoms abating in severity, the pulse and skin becoming soft, and the pain losing its throbbing character.

2. *Pointing* is a symptom of great importance in the diagnosis of a phlegmonous abscess. It is always most conspicuous where there are, or were, most pain and discoloration, and naturally the least amount of resistance in the overlying structures. The skin looks dusky, purple, or livid, and feels thin and attenuated, as if it were ready to give way, as, in fact, it generally is. A tumor, benign or malignant, may also point, but a careful consideration of the history of the case commonly suffices to show the difference.

3. *Fluctuation* in an abscess necessarily implies the existence of mobility. If the matter lies near the surface, it may readily be displaced on one side, and rendered correspondingly prominent on the opposite. Two methods may be adopted in conducting the examination. In one, alternate pressure is made with the hands or fingers resting upon opposite points of the abscess. As one hand or finger sinks in, the other is elevated, a circumstance clearly denotive of the existence of fluid, although the fluid may not be purulent. The other method consists in percussing the tumor with one hand, the other hand being placed upon the opposite side. If matter be present, an undulatory motion will be imparted, one of the surest signs of suppuration. This method, however, is less delicate than the other, and is applicable only to abscesses of unusual volume. When the matter is seated superficially, its presence may often be detected by passing the finger over the most prominent part of the swelling, when, if there be pus, it will generally sink in a little, in consequence of the skin at that part offering less resistance than at the periphery of the tumor. This method of examination is particularly adapted to small abscesses of the scalp, perineum, tibia, clavicle, fingers, and other superficial portions of the skeleton. Finally, one may often readily satisfy himself of the existence of pus by grasping the suspected swelling, especially if it be very small, with the thumb and forefinger, and then, while the skin is thus stretched or rendered tense, pressing upon the top of the swelling with the index finger of the other hand. Such a mode of exploration is particularly valuable in abscesses of the mamma, testicle, subcutaneous connective tissue, and lymphatic glands of the neck, groin, and axilla.

There are certain parts of the body, which, under the influence of disease and injury, impart a deceptive sensation of fluctuation, as the dorsal surface of the hand, the forearm on a level with the head of the radius, the calf of the leg, the upper and outer aspect of the thigh, and the inner and upper portion of the thigh on a level with the iliac and psoas muscles. A similar condition occasionally exists in the temple. Without a knowledge of these facts, the occurrence of swelling in these regions might readily induce the surgeon to use his bistoury when there is no matter.

4. Valuable information is often afforded by the appearance of the *swelling*. Thus, when the matter is very deep seated, as in an abscess of the thigh, the existence of œdema is nearly always decisive of the nature of the case, especially when it is conjoined with a hard, brawny state of the parts. The fluid cannot, from the manner in which it is bound down, reach the surface, but its presence causes inflammation in the skin and connective tissue, leading to an effusion of serum, and consequently to more or less pitting under the pressure of the finger. In empyema, or purulent collections in the pleura, œdema of the chest, directly over the seat of the fluid, is usually a prominent, and, indeed, in many instances, a characteristic symptom. A puffy, œdematous state of the scalp is often denotive of abscess of the brain and dura mater, in injury of the skull.

Although œdema is in general a valuable sign in suppuration, it occasionally exists in a very high degree without any pus. A few years ago I saw a case of acute sarcoma of the hip and thigh in a young lady of twenty-six, where the quantity of serum in the subcutaneous connective tissue was so great as to produce the most decided fluctuation at various points of the swelling, and yet not a particle of matter followed the insertion of the bistoury.

5. The *affections* most liable to be mistaken for abscess are sarcoma, aneurism, hernia, cystic tumors, and local œdema. From the first of these the history alone of the case will generally suffice for a correct diagnosis. Sarcoma is a chronic affection; a phlegmonous abscess an acute one; the first is attended with little or no pain until ulceration sets in; the latter with a great deal, generally from the moment it begins until it is evacuated.

An abscess may be mistaken for an aneurism, especially if it be seated over a large artery, which communicates to it its impulse. Errors of this kind are most likely to happen when the disease occupies the axilla, neck, groin, or ham, where the tumor receives an impulse from the vessel below. An aneurism of the thoracic aorta, perforating the chest, has occasionally been opened under the supposition of its being an acute abscess. The history of the case, the discoloration of the skin, the imperfect outline of the swelling, and the conical projection on the surface, will generally suffice to differentiate the two affections. An aneurism is usually of slow formation, and does not for a long time manifest any disposition to approach the surface. The disease, moreover, is most common in elderly subjects, whereas abscesses occur at all periods of life.

A strangulated hernia of the groin, abdomen, or upper part of the thigh might be mistaken for an abscess, but such an accident could hardly happen in the hands of an experienced surgeon. The history of the case, the peculiar character of the swelling, and the existence of symptons of strangulation will always be sufficient to clear up any doubt that may arise respecting the nature of the affection.

A serous cyst has occasionally been mistaken for an abscess. Such an error can only occur when the cyst takes on inflammation, attended with discoloration, pain, and fluctuation. The mere site of the tumor is generally sufficient to indicate its true nature, independently of its history.

An acute abscess may be confounded with local œdema of the connective tissue, circumscribed, elevated, puffy, discolored, and more or less painful. The occurrence is most common in the hand and foot, and in the neighborhood of some of the joints, especially in cases accompanied by a considerable effusion of synovial fluid.

6. When, notwithstanding the most thorough scrutiny of the case, the diagnosis remains uncertain, the exploring needle will often decide the question in a moment. The instrument which I usually prefer is an ordinary cataract needle, introduced at the most prominent part of the swelling down to its very centre, and freely rotated upon its axis, in order to condense the walls of the puncture, and thereby facilitate the flow of fluid. If the contents be purulent, the circumstance will be revealed by the appearance of a drop of pus at the orifice; whereas, if the swelling be an aneurism, the discharge will be sanguineous. If the tumor be sarcomatous simply a little blood will probably escape.

Sometimes the diagnosis of a suspected abscess may readily be determined by the aspirator. A small canula having been introduced into the swelling any fluid that may be present rushes at once into the exhausted receiver, and thus reveals the true nature of the affection.

Prognosis.—The prognosis of this disease is influenced by a variety of circumstances, of which the most important are the size, number, and seat of the abscesses, and the age, habits, and constitution of the patient.

A large accumulation of pus is, other things being equal, more dangerous than a small one, because it not only produces more havoc among the tissues, but it exerts more severe pressure upon the surrounding parts, and establishes a greater drain upon the system. Number has an important bearing upon the prognosis. A man may struggle through several abscesses, even when of considerable bulk, but when he is laboring under a great many he will be extremely fortunate if he do not sink under them. Smallpox is always a dangerous disease, chiefly on account of the immense number of abscesses which attend its progress, few patients being able to withstand the irritation and consequent prostration occasioned by their development. The situation of the matter is an object of importance. Thus a small abscess of the perineum may cause fatal retention of urine, as one of the fauces may induce death by compression of the glottis. Importance of structure also influences the issue of the case. An abscess of an internal organ, as the liver, is more dangerous, and more likely to prove fatal, than an abscess of an external part of the body, as a lymphatic gland.

The recovery of a person laboring under phlegmonous abscess is often materially influenced by his age, habits, and state of constitution. Young adults and middle-aged subjects usually get on better than children and very old persons, who often meet such attacks very poorly, making a very feeble show at resistance. The intemperate man has a worse chance than one of good habits, and the man of bad previous health than one who has always had an excellent constitution.

Treatment.—The treatment of phlegmonous abscess is conducted upon general antiphlogistic principles; at first, by depletion, purgatives, antimonials, and the ordinary topical means, to limit deposit and save structure; and afterwards, by the lancet, to pro-

mote evacuation and repair. Sometimes spontaneous removal is permitted, as when the abscess is seated immediately beneath the periosteum as an effect of tertiary syphilis, or when it occupies a lymphatic gland, and has as yet made little progress; favored, if necessary, by the administration of mercury and iodide of potassium, and the application of iodine, blisters, and other sorbefacients. But such cases are exceptional, and do not affect the general rule of practice, which always seeks an early outlet for the pent-up fluid. In some situations we do not even wait for well-marked pointing, much less distinct fluctuation; but assured that matter is present, make an early and free incision, thus abridging suffering and saving structure. The beneficial effects of this practice are strikingly illustrated in abscesses in various parts of the body. Thus, in purulent collections around the anus, an early outlet is indispensable, otherwise the matter will be sure to burrow along the side of the rectum and to perforate its walls, thereby forming an anal fistule. An abscess of the perineum requires prompt interference to prevent retention of urine and the establishment of urethral fistule; of the fingers, lest the matter should travel along the sheaths of the tendons and so produce extensive sloughing and necrosis; of the fauces and tonsils, to prevent suffocation by the pressure of the swelling upon the glottis. The torturing pain of a gum-boil, an abscess of the jaw, is often instantly relieved by an early and free incision. The same procedure in deep-seated abscess of the extremities not only moderates pain and constitutional irritation, but prevents the pus from burrowing among the muscles, and so causing extensive destruction of the connective tissues.

An abscess should be opened early when, from its proximity to a large vessel, there is danger that a communication may be established between them, thus leading to fatal hemorrhage. Such an event will be more particularly liable to occur in delicate children, laboring under the effects of scarlatina, measles, or smallpox, and in elderly subjects worn out by long suffering and an impoverished state of the blood.

Fig. 14.

Mr. Liston's Case. *b*. The External Opening of what was an Abscess *a*. The Ulcerated Communication between the Cyst and the Carotid Artery: the latter has been sliced open. *c*. The Pneumogastric Nerve.

The vessels most subject to this danger are those about the neck. In Mr. Liston's celebrated case, the abscess opened into the common carotid; it was punctured and the patient perished from hemorrhage. The parts are represented in fig. 14. In an abscess of the neck, involving the thyroid artery, asphyxia has been suddenly induced by the escape of blood into the windpipe. Billroth met with an abscess at the base of the skull, in which, in consequence of disease of the internal carotid artery, death finally resulted from profuse hemorrhage of the right ear, nose, and mouth despite the ligation of both common carotids.

Artificial evacuation may be effected with the knife or with caustic. The latter, at one time so much in vogue, is now seldom employed, and it would be difficult to conceive what possible advantage it could possess over the former, which is incomparably more expeditious, less painful, and more certain. A surgeon should not so far humor a patient as to use caustic when his judgment plainly condemns it, simply because he is foolishly timid, especially now that all apprehension and suffering may be so readily prevented by the administration of anæsthetics; nor should he, on the other hand, resort to caustic with the view of promoting suppurative action, since there are always at our command articles far more desirable and efficacious. If, however, such a remedy should be called for, the best one is Vienna paste, applied as in making an ordinary issue, the eschar being afterwards penetrated, if need be, by the bistoury, now no longer dreaded by the patient.

Various instruments are employed for opening abscesses. The awkward, clumsy thumb lancet, which formerly figured so conspicuously in every pocket-case, is now seldom used, having been advantageously superseded by the scalpel and bistoury. The scalpel is, however, rarely employed, except in very large abscesses, when it is necessary to make a very free division of the overlying structures. By far the neatest contrivance for the purpose is the little bistoury, represented in fig. 15, which I have used almost exclusively for
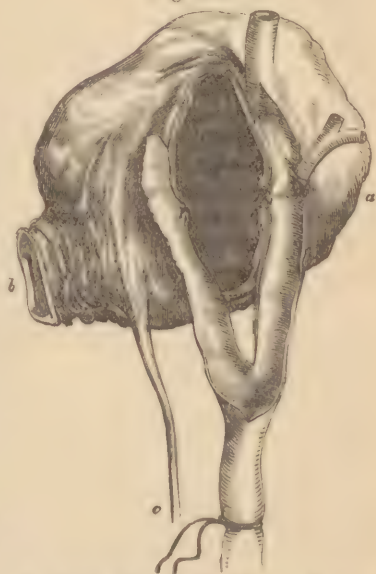
Fig. 15.
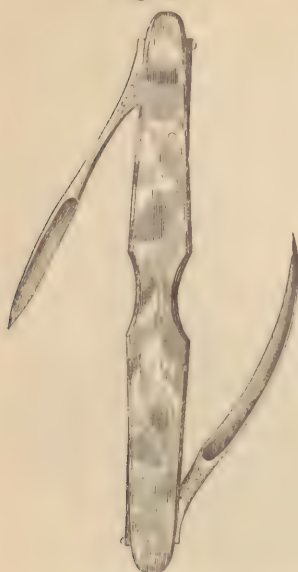
Abscess Bistoury.

many years. It consists of two very narrow, sharp-pointed blades, one straight, and the other slightly curved, short, yet long enough to reach to the desired depth in almost any conceivable case. Selecting the most prominent, and, if possible, also the most dependent, portion of the abscess, the instrument is plunged perpendicularly through the skin, into the very midst of the matter, its arrival there being indicated by a want of resistance and probably also by an escape of a few drops of fluid, especially if this be thin. The puncture thus made is then converted into an incision, by depressing the handle of the bistoury, and cutting from within outwards, the length of the opening varying, on an average, from a third of an inch to an inch, according to the volume of the abscess. In general, it is better that the opening should be too large than too small, as the object always is to afford free vent to the pent up fluid. Care, of course, is taken, in introducing the bistoury, not to interfere with any important vessels and nerves, or to perforate any important cavity.

In large abscesses, attended with great destruction of the connective tissue, and extensive separation of the muscles, the course of the arteries is sometimes completely changed by the pressure of the accumulating fluid; and hence the surgeon, if not fully upon his guard, may, in making this puncture or incision, cause very serious, if not fatal hemorrhage. The best way to avoid such an accident is to ascertain carefully, beforehand, the situation of the vessel, as may usually be done by its pulsation.

When the abscess is very deep seated, as, for instance, when it occupies the muscles of the thigh, the walls of the abdomen, the groin or axilla, the safest plan is to divide the skin and fascia freely with the knife and grooved director, employed in the same cautious manner as in the removal of a deep-seated tumor.

Penetration having been effected, the matter usually escapes of its own accord, simply by the pressure of the atmosphere; but the evacuation may be aided, if necessary, by the hand or finger, used, however, with the greatest gentleness, otherwise it may occasion not only severe pain, but an aggravation of the inflammatory action. Too much caution, indeed, cannot be observed in this particular. Nothing can be more reprehensible than the rude manipulations that are so often practised after this operation, even by surgeons otherwise well educated. To prevent the incision from healing by the first intention, and the necessity of the repeated use of a knife, a small, well oiled tent, made of old linen, is interposed between the edges, one extremity being carried a short distance into the now empty sac, and the other left slightly pendant externally, substitution being effected once in the twenty-four hours. Or, instead of a tent, a drainage tube may be used to carry off the matter as fast as it is formed; the caliber of the tube should be of good size, and the side openings should be large, otherwise they will soon become clogged, and thus become a source of mischief. The best application for the surface of the abscess is an emollient cataplasm or a cloth wrung out of tepid lead water; but this should not be made until bleeding has ceased, otherwise troublesome hemorrhage might ensue. As soon as the parts have become perfectly comfortable, the warm dressing is discontinued, on account of its relaxing tendency, a piece of lint, spread with simple cerate, or wet with olive oil, being used in its stead.

When the matter is seated in a bone, evacuation must be sought with the trephine; but the operation is not always successful, owing to the difficulty of the diagnosis.

When the abscess is of large size, or when it has occasioned extensive separation of the muscles, its sides should be approximated, after evacuation, by means of a thick and well-adjusted compress, secured by adhesive strips, or, in the event of the matter being seated in an extremity, by the common roller, extending upwards from the distal part of the limb, care being taken not to interfere with the artificial opening. In this way a cavity that might otherwise not close under several weeks, will often be effectually obliterated in a few days.

Large abscesses are often immensely benefited, especially if slow in healing, by being thoroughly washed out several times daily with weak solutions of carbolic acid, chloride

of zinc, or chlorinated sodium.   These fluids, judiciously used, allay fetor, arouse healthy action, promote repair, and lessen the danger of purulent infection.

An abscess is sometimes prevented from healing by the unfavorable position of its opening, whether natural or artificial, the matter accumulating in a kind of pouch, situated between the orifice and the bottom of the swelling.   Such a condition calls for what is termed a *counter-opening*, which is easily established by making an incision at the most dependent part of the sac, upon the end of a grooved director, introduced through the previous and now useless aperture.   Counter-puncture is often necessary in abscess of the neck and parotid region, from the gravitating tendency of the matter in these situations. Sometimes, again, an opening of this kind is called for on account of a change in the position of the part after the first operation, performed perhaps well enough at the time. Whatever may be the causes demanding it, patency is maintained with more care, if possible, than under ordinary circumstances.

Again, repair may be rendered tedious, if not impracticable, by the existence of a *sinus*, extending, perhaps, deeply among the surrounding parts, or, it may be, communicating with some natural cavity.   The most speedy and effectual remedy is incision with a bistoury upon a grooved director, inserted into the bottom of the track, the parts being thus laid into one, and permitted to heal by granulation, readhesion being prevented by the constant interposition of a piece of lint.   In the milder cases, steady and systematic compression sometimes succeeds in obliterating the abnormal channel; sometimes, again, gently stimulating injections are useful; and, finally, there is a class of cases in which the seton is worthy of trial.   In general, however, these means only serve to amuse the patient and annoy the surgeon, who is at last compelled to have recourse to a remedy which he should have employed in the first instance.

Hemorrhage from extension of ulcerative action into a neighboring artery or vein may be so profuse as to endanger if not destroy life, either speedily or more or less remotely. In most cases it will be found to be very troublesome from the difficulty that is experienced in ascertaining its source.   The proper remedy is the ligature, the vessel being seized and drawn out with the forceps or tenaculum, or compressed with a needle confined with a stout thread, after the manner of a twisted suture.   Gentle compression sometimes answers the purpose, especially if the bleeding be venous, or if it proceed from a number of small points.   If an artery of considerable size has been opened, and cannot be easily reached, the incision should be enlarged to effect the necessary exposure.

When the bleeding is capillary or when the blood escapes from numerous points, as it sometimes does when the vessels have lost their support, from their inability to contract and retract, in consequence of the destruction of the connective tissue and the effusion of plasma, the best plan generally is to lay open the abscess freely, and to cover the raw surface with lint, wet with a solution of subsulphate of iron, and confined with a compress and bandage.   In a case recently under my care, in which a chronic phlegmonous abscess of the nates had been the seat of repeated copious hemorrhages, I exposed the entire cavity, turned out the clotted blood, and scraped away all the unhealthy granulations, thus placing the parts in a proper condition for rapid repair.   No bleeding occurred afterwards.   The coagula which had been confined in the abscess had evidently contributed to keep up the hemorrhage.

When an artery or vein of considerable size has been accidentally opened, the treatment must be conducted upon the same general principles as when the hemorrhage is produced by ulcerative action.   If direct means fail, the main trunk of the vessel, especially if it be an artery, must be exposed and ligatured.   In such a case no delay should be permitted in applying the proper remedy.

The *healing* of an abscess, whatever may be the manner of its evacuation, is effected by the contraction and approximation of its walls, which generally begin the moment the matter has escaped, and steadily progress until the sac is completely obliterated.   The raw state of the opposed surfaces strongly predisposes them to unite with each other, an occurrence which is always favored by an effusion of plasma.   If the cavity of the abscess were obliterated, as was formerly supposed, by granulations, the part would remain hard and prominent for a long time; but this is not the case.   On the contrary, it soon shrinks, becomes soft, and drops down to a level with the surrounding surface.   The opening alone unites in this way; but even this is not always so, for examples constantly occur of closure by the first intention.

Although the outer wall of the abscess generally soon recovers its pristine softness and pliancy, occasionally the reverse is true, the parts remaining hard, tender, enlarged, and seemingly reluctant to throw off their inflammatory burden.   To expedite resolution, the

affected surface may be covered with an ammoniac and mercurial plaster, commonly the very best remedy that can be used for the purpose ; or it may be rubbed several times a day with some sorbefacient liniment, unguent, or embrocation, aided, perhaps, by the bandage and a few alterative doses of mercury. A bran poultice, prepared with salt water, is often a most efficient application.

Constitutional treatment must not be neglected. Indeed, there are few cases in which this is not absolutely necessary. This is especially true in all severe cases of phlegmonous abscesses, in which the copious discharge of pus, the high fever, and profuse sweats so generally present, always establish a serious drain upon the system. The remedies mainly to be relied upon are quinine and iron, particularly when there is marked anemia, quinine and the mineral acids, milk punch, beef essence, and, above all, opium and fresh air. When convalescence is unusually slow, a residence at the seaside often proves beneficial ; and when digestion and assimilation are seriously at fault, cod-liver oil will be worthy of trial. For the relief of night-sweats the best remedies are aromatic sulphuric acid, atropia, or oxide of zinc, either alone or in union with opium.

2. DIFFUSED ABSCESS OR PURULENT INFILTRATION.

The above is one variety of phlegmonous abscess ; the circumscribed, in which, united with rapidity and severity of action, the matter is bounded by a distinct wall of fibrin, serving the purpose of a cyst, although in reality there is no such formation. In the present variety, already incidentally adverted to, there is no connective exudation, and the consequence is that the pus is widely diffused among the surrounding structures, dissecting and separating them from each other in the most frightful manner. Such collections, which are generally attended with intense suffering, are often described under the appropriate and expressive appellation of purulent infiltrations, the result always of cellulitis.

The diffused form of abscess is met with under a great variety of circumstances, both as it respects the nature of the exciting cause and the condition of the general system. It is most common in persons whose constitution has been dilapidated by intemperance in eating and drinking, by want and exposure, and by organic affections of the heart, lungs, liver, bowels, and kidneys, leading to anemia, obstructed circulation, and exhaustion of the vital powers. When such persons meet with a serious accident, or suffer from a prolonged attack of fever, suppuration is extremely prone to take on this kind of action, often sadly complicating the original disease. Diffused abscesses are also sufficiently common after severe injuries, as compound fractures and dislocations, lacerated, railway, gunshot, and dissection wounds, and capital operations, especially amputations of the larger limbs and resections of the bones and joints. Persons of a scrofulous constitution are, on the whole, more liable to suffer from diffused suppuration than any other class of individuals, their vital powers being too feeble to furnish a sufficiency of fibrin to limit the purulent matter.

Diffused abscesses may occur independently of any other appreciable disease, or they may arise in conjunction with erysipelas, pyemia, or phlebitis, which they resemble very much both in their mode of origin and in the character of their symptoms. Their presence, in fact, is always denotive of a bad, depraved, or degraded state of the system ; in some cases the fault apparently lies in the blood, either in a defect of some of its more important constituents, or in the ingress of some morbid poison ; in others, again, it seems to be due to imperfect action of the skin and kidneys, excess of food and drink, the respiration of impure air, overaction of the brain, or exhaustion of the nervous system.

The symptoms of this variety of abscess are ordinarily bold and well defined. In general, the disease is ushered in by considerable shivering, if not by a severe rigor, followed by heat and perspiration ; the pulse soon becomes small, quick, frequent, and irritable ; the extremities are cold, the urine is scanty and high-colored, the appetite is destroyed, the tongue is covered with a brownish fur, the strength rapidly declines, and the patient soon sinks into a state of delirium. Great irritability of the system exists ; the pain is often excessive, sleep is interrupted, and the mind is peevish and fretful. Frequently the symptoms are of a typhoid character from the beginning ; if not, they are sure soon to become so ; and yet not merely typhoid, but typhoid and irritative, the two classes being generally well balanced throughout.

The local symptoms are those of ordinary inflammation, only that they are more severe, especially when the matter is deep seated. The discoloration is of an erysipelatous nature, the parts are swollen and pit on pressure, the pain is smarting and pulsatile, and

the skin feels hot, stiff, and numb.   If the matter lies immediately beneath the surface, or among the more superficial muscles, a boggy sensation will be imparted to the hand of the examiner, and a little pressure will be sufficient to push the fluid about from one place to another, sometimes to a distance of many inches.   When, on the contrary, the pus lies far below the surface, bound down by muscles and aponeuroses, its early detection will generally be very difficult; under such circumstances, the best guide to its situation will be the history of the case, the deep-seated pain, the presence of œdema of the skin and connective tissue, and the character of the constitutional phenomena.   If any wounds or sores exist, they speedily dry up, and assume an unhealthy appearance.

Although any part of the body may become the seat of diffused abscesses, their most common sites are the limbs, in which the matter often burrows to a great extent, both beneath the integuments and among the muscles; in some of the worst forms that I have ever seen, it lay in immediate contact with the bones, separating them from the soft structures, and even from the periosteum.   In one case under my observation, the fluid had spread along the posterior surface of the lower extremity, in close contact with the femur and the bones of the leg, from the hip as far down nearly as the heel.   The matter is generally thin, sanious, irritating, acrid, and excessively offensive, often tainting the atmosphere of the apartment for many feet around, and fastening itself upon the hands and clothes so as to be perceptible for hours afterwards, notwithstanding, perhaps, the liberal use of deodorizers.   In fact, the stench is usually most disgusting.   In some cases the fluid approaches more nearly to the properties of ordinary pus, but this is uncommon.   Occasionally extensive sloughs form, especially in the connective tissues, so that the disease may be said to partake of the character both of suppuration and of gangrene.

The prognosis of this form of abscess is generally very unfavorable, few constitutions being able to withstand its depressing effects.   The very fact that such a disease is in operation shows, as already stated, that the system is in a depraved condition; and when it is recollected that some of this foul matter must necessarily find its way into the circulation, contaminating everything with which it comes in contact, it is not difficult to anticipate what the result will be likely to be, even when the purulent collection is not very extensive, especially in persons already exhausted by shock, loss of blood, or lesion of some important organ.

The *treatment* of diffused abscess is sufficiently obvious.   The leading indications are to evacuate the matter, and to support the system.   The first is fulfilled by early and free incisions, practised at the most favorable site for ready drainage, with the precaution of avoiding hemorrhage, the smallest quantity of which is sometimes sufficient, in such an event, when life is, as it were, quivering in the balance, to bring on fatal exhaustion.   Counter-openings are often necessary.   After the abscess has been thoroughly evacuated and cleansed, its sides are gently approximated with the bandage, a means of support of the greatest value, not only in preventing the extension of the matter, but in promoting the healing of the parts.   So long as the fluid is offensive, the abnormal cavity should be well syringed several times a day with tepid water, charged with a suitable quantity of chlorinated sodium and permanganate of potassium, or creasote, chloride of zinc, acid nitrate of mercury, or carbolic acid, to correct fetor, and to impart tone to the disabled structures.   Any sloughs that may form should be speedily removed, the knife being used, if necessary, to effect their separation.   The parts are placed in a proper position for facilitating drainage, and are enveloped in warm-water dressing, or an emollient medicated poultice, with acetate of lead and opium.   Compression is steadily employed until the sac is obliterated.

Among the more valuable internal remedies are anodynes, quinine, iron, and brandy, with animal broths and soups, and a pure atmosphere, which is of paramount importance to recovery.   The windows and doors of the apartment should be frequently thrown open, the dressings changed, and disinfecting agents used.   Anodynes are indispensable to allay pain and induce sleep, and should be administered in full doses, in the form of morphia, opium, or black drop.   The best tonics are quinine and brandy, given in the same manner as in typhoid fever; the tincture of chloride of iron, in doses of fifteen to twenty drops, every three or four hours, will also be of service; and, in many cases, ammonia, in camphor mixture, will meet the exigencies of the case better than almost any other remedy, especially if there be hiccough with twitching of the tendons.

3. SCROFULOUS ABSCESS.

The scrofulous abscess is known by various names, some of which have reference to its progress, some to its symptoms, some to the nature of its contents, or to the state of the constitution preceding and accompanying its formation. Thus, it is often described as the chronic abscess, tardy development being one of its characteristic features; the word cold is frequently employed on account of the absence of inflammatory symptoms; but scrofulous is the appellation by which it is generally distinguished at the present day. As implying the same thing, the terms strumous and tubercular are much in vogue. There is a form of this abscess to which the name congestive has been applied, from its tendency to change its position, although it is impossible to discover any etymological fitness in it.

The scrofulous abscess is altogether a singular affection; singular in its origin and progress, its termination and its treatment. It is never met with, except in the strumous constitution. The phlegmonous abscess is common to all persons, of every age, grade, and condition in life; the scrofulous, on the contrary, can only occur in persons who have a predisposition to scrofulous affections, whom nature has stamped, so to speak, with a peculiar diathesis, or state of the system, rendering them prone to phthisis, coxalgia, caries of the spine, and kindred maladies. Its sphere of action is, therefore, comparatively limited, a hundred cases of phlegmonous abscess occurring to one of a scrofulous character.

The progress of the scrofulous abscess is always slow, weeks and months usually elapsing before it acquires any considerable bulk: hence the term chronic, by which it is so frequently designated. A phlegmonous abscess, on the contrary, is always rapid in its progress, generally attaining its full development in a very short time. Another peculiar feature of the strumous abscess is the absence of the ordinary inflammatory symptoms. The skin, instead of being hot and red, is cold and blanched, the part feeling and looking as if there were great deficiency in its circulation. Hence this variety of abscess used to be termed cold, especially by the German surgeons, who were the first to describe it. Pain, too, is absent, or, if it exist, it is so trivial as hardly to attract attention. Functional disorder also is very slight, especially in the earlier stages of the disease. Looking at the constitution, the same uncommon train of phenomena is observed. The general health may be somewhat impaired; the strength may slowly and almost imperceptibly decline, and the countenance may have a pale, sallow appearance; but there are none of the open and well-marked inflammatory symptoms which attend the march of a phlegmonous abscess, and which, especially when the disease is located in an important internal organ, suggest the idea of great and immediate danger. Thus, as far as appearances are concerned, the affection is one seemingly of little moment; its discovery is often purely accidental, and, for a while, both patient and surgeon may be wholly unconscious of its true character. It is, indeed, as completely different from an ordinary abscess as it is possible for one disease to be from another. Scarlatina and measles are not more unlike each other.

The strumous abscess is very frequent in the lymphatic glands, subcutaneous connective tissue, and in the dorso-lumbar region. The testicle, breast, and liver are also sometimes its seat. It is, however, more common in the lungs than anywhere else, for there it is the immediate product of the softening of tubercular matter, eventuating generally in the formation of what are termed vomicæ or pulmonary caverns. In the external parts of the body it is usually situated in the neck, on the chest, in the axilla, on the loins, in the groin, or upon the superior portion of the thigh. Large strumous accumulations sometimes occur in the movable joints.

As to the size and number of these abscesses, considerable diversity obtains. In certain situations, as in the lungs, they are always small, but at the same time often very numerous; while in others, as in the cervical glands, on the chest, in the groin, and on the back, they are usually single, and from the volume of an orange to that of a fœtal head.

The strumous abscess is nearly always furnished with a distinct cyst, called the *pyogenic* membrane, which, while it serves to individualize it, separates it effectually from the surrounding parts. At what period of the suppurative process the membrane appears is not determined, but that it is developed at an early stage is unquestionable. It has been supposed that its formation, at times, precedes the formation of the pus. The subject, however, does not admit of easy demonstration; for it is seldom that an opportunity is afforded of inspecting such an abscess until after it has attained considerable bulk, and the membrane has acquired some degree of development. The most plausible conjecture,

perhaps, is, that the membrane is formed as a matter of necessity, nature intending it as a means of limiting the diffusion of the pus, as would otherwise inevitably happen in consequence of its tardy but steady deposition. To accomplish this object, she sets up around the purulent depot, at an early period of the morbid action, a species of adhesive inflammation, by which, in the first place, the cells of the neighboring tissues are effectually occluded, the process being precisely similar to that which occurs in an ordinary phlegmonous abscess. Thus, the fluid is temporarily circumscribed, but, as may readily be perceived, the barrier thus opposed would soon yield before the accumulating burden, and thus thwart nature's intentions, if it were not that a wall of plastic matter is next constructed, which no amount of pus, however great, can, for a time, break down or destroy. The thickness of this wall varies from the eighth of a line to the eighth of an inch ; its density steadily increases with its age, and hence it is often found to be of a fibrous consistence, with here and there a semi-cartilaginous patch. Its outer surface is rough and intimately united with the surrounding structures ; the inner, on the contrary, is either perfectly smooth, or studded with minute granulations, not unlike the villi of the small intestine, only not so regular and numerous. Its vascularity, which is always considerable, is easily distinguishable by the naked eye, as well as by minute injection. It also, no doubt, contains nerves and absorbents, although they are not demonstrable.

No one can reflect upon the structure of this membrane without being impressed with the conviction that it is invested with important functions. In the first place, as already stated, it protects the tissues in the immediate neighborhood of the abscess from the diffusion of its contents ; a circumstance which could not fail to be productive of great injury, inasmuch as the matter, burrowing about in different directions, might occasion extensive separation of the muscles, which it would afterwards be extremely difficult to remedy. Secondly, the membrane is an important secreting structure, since it furnishes the matter which it incloses, either directly, or indirectly through the agency of lymph, speedily transformed into pus. Thirdly, it is also an absorbing structure, as is proved by the fact that the matter which it contains occasionally disappears, either spontaneously, or under the influence of treatment. Finally, the membrane possesses important sympathies with the rest of the system. Left to itself, it causes no general disturbance, but the moment it is opened so as to admit the entrance of air, it resents the aggression, and is sure to occasion severe constitutional derangement.

The pus of a strumous abscess is generally of a whitish or yellowish cast, slightly inclining to greenish, of a tolerably thick consistence, free from odor, and intermixed with caseous particles, looking and feeling very much like pieces of soft-boiled rice. Instances occur, especially in scrofulous disease of the lymphatic glands of the neck, where it is very thin, pale, and full of curdy substance, consisting apparently of imperfectly broken-down tubercular matter. When long retained, or situated near the anus and rectum, scrofulous pus is sometimes excessively fetid, either from actual decomposition or from the presence of sulphuretted hydrogen. Permitted to stand for some time, it separates into two parts, one of which is thin, whey-like, or sero-oleaginous in its appearance, the other thick and curdy, the former being always upon the top of the latter. Like the pus of a phlegmonous abscess, it occasionally contains the debris of the organs in which it is formed, and also some of their peculiar secretion. Thus, a strumous abscess of the liver may contain bile ; of the breast, milk ; of the spine, osseous particles. The microscopic characters of scrofulous pus are well illustrated in fig. 19, from Jones & Sieveking.

In regard to quantity, there is much variety in the pus of this form of abscess. In psoas abscess, one of the best examples of the disease, the accumulation is sometimes enormous, reaching several quarts, or, perhaps, even a gallon. In scrofulous abscess in the glands of the neck, there is also occasionally a good deal of pus, although, in general, it is small. Large collections of strumous matter are sometimes seen in chronic abscess beneath the skin, especially in the lower extremity. A young woman, a patient at the College Clinic, had an abscess of this kind on the left thigh, containing nearly a gallon of pus.

The contents of a chronic abscess are sometimes remarkably thin and pale, or almost watery, being composed essentially of the serum of the blood, with few, if any, well-developed pus globules. Flakes of fibrin and broken-down connective tissue are occasional ingredients of such fluids, which sometimes exist in enormous quantities, especially in young, scrofulous subjects,

Fig. 16.
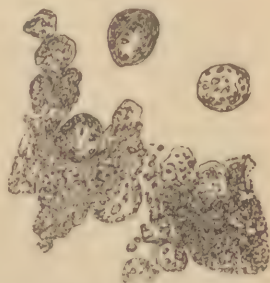
Pus from a Scrofulous Abscess.

of an anemic appearance and dilapidated constitution. The pyogenic membrane, also, is generally uncommonly thin and imperfectly organized. Abscesses of this kind, formerly known as lymph abscesses, are most common about the hips and nates, and in the upper part of the thigh.

The diagnosis of the strumous abscess may be gathered from the remarks already made respecting that of phlegmonous abscess. The principal affections with which it is at all likely to be confounded are aneurism, and various kinds of tumors, as the cystic and sarcomatous. In the groin and upper part of the thigh such an abscess might be mistaken for hernia. From these affections, however, it may usually be easily distinguished by the history of the case, the fluctuating character of the swelling, and, if necessary the use of the exploring needle, the latter of which seldom, if ever, fails to furnish the requisite light.

When a cure takes place in a strumous abscess, whether spontaneously or by art, the cyst gradually shrinks, and is ultimately completely obliterated, the wall itself finally disappearing. In exceptional cases, however, a portion of the structure remains, generally in an unsound condition, and, therefore, liable to fresh attacks of inflammation, years, perhaps, after the apparent obliteration of the sac. Such an event will be the more likely to occur when, as not unfrequently happens, some of the contents of the abscess are retained in the form of half-dried, shrivelled, and disintegrated matter, which may thus, at any time, become a source of irritation, provoking not only inflammation, but more or less profuse suppuration, the development of abscesses, and constitutional disturbance. These residual or recurring abscesses are most prone to form in connection with Pott's disease of the spine, and other portions of the skeleton, generally as a consequence of external injury, or protracted disease, seriously undermining the vital powers.

Treatment.—The treatment of this abscess differs essentially from that of the phlegmonous. In the latter, the system often bears energetic measures ; in the former, seldom, if ever; in the one, the surgeon does not hesitate to make an early and free incision into the swelling, with a view to the early evacuation of its contents ; in the other, he waits and hesitates, well knowing that such an operation is often the prelude to serious constitutional disturbance, if not death. The one is the work of a few days, or, at most, of a few weeks, taking the part and system, as it were, by surprise, and, therefore, requiring prompt interference ; the other is the work of time, affording the part and system an opportunity of accommodating themselves to its presence, and, therefore, often intolerant of interference. When the quantity of matter is small, removal is occasionally effected by absorption, the process being sometimes advantageously aided by internal and external remedies, especially the iodide of potassium and the bichloride of mercury, together with sorbefacient plasters, unguents, and embrocations. These means are more particularly available in chronic abscesses of the glands of the neck, groin, and axilla, and in those of the mamma and subcutaneous connective tissue. In psoas and lumbar abscesses, on the contrary, little or no benefit usually results from their employment, beyond the influence which they may exert in improving the general health, and in eradicating the strumous diathesis. When general debility exists, relief should be attempted with tonics, as quinine and iron, along with cod-liver oil, milk punch, and change of air.

When a scrofulous abscess is seated in an external part of the body, as the mamma, a lymphatic gland of the neck, or the subcutaneous connective tissue, the only rational treatment is the evacuation of its contents. In such cases, indeed, it is hardly possible to make too early or too free an incision ; for, not only is there, generally, no danger of causing constitutional disturbance, but the procedure is eminently calculated to save structure and promote recovery. The matter being thus disposed of, the cavity usually at once contracts, and, the tendency to secretion gradually diminishing, the part finally heals by granulation or adhesion. Besides, such a procedure always enables the surgeon to watch the morbid action, and to apply his remedies directly to the affected surface.

The best local applications, after the abscess has been punctured, are emollient poultices, rendered slightly stimulating by the addition of a little common salt ; or tincture of iodine, spirituous lotions, or some sorbefacient plaster, as the ammoniac and mercurial, soap, compound galbanum, or iodine plaster, care being taken to leave an appropriate opening for the discharge of matter. I can speak with great confidence of the beneficial effects of these agents, especially the first, from my experience of them in the treatment of strumous abscess of the neck, mamma, and subcutaneous connective tissue. When the cavity of the abscess is slow in healing, on account of the torpor of its vessels, or the existence of a strong pyogenic membrane, nitrate of silver, carbolic acid, acid nitrate of mercury, or chloride of zinc, may be employed, in the form of weak injections, as local stimulants,

until there is a disposition to the formation of healthy granulations. Sometimes, as in the case of a subcutaneous abscess, a seton may advantageously be introduced, retention being maintained until the sac is obliterated by inflammation. Or, instead of this, a counter-opening may be made, and a tent inserted. Or, if the sac is small, it may be dissected out. As a rule, when the abscess is small, the best plan is to lay it freely open, and to scrape away all unhealthy and disintegrated matter, a step which wonderfully promotes the cure.

When the abscess is connected with disease of the bones, as it generally, if not always, is when it takes the name of psoas or lumbar abscess, the treatment formerly in vogue was that originally suggested by Abernethy, which consists in making a valve-like open-ing into the most prominent or most dependent part of the swelling, and drawing off only a portion, as one-half or two-thirds of its contents at a time, the operation being repeated every fourth or fifth day according to its effect. Educated in a school in which this practice was strongly inculcated, and warmly prepossessed in its favor, I followed it until the accumulated experience of many years satisfied me of its utter uselessness, and I therefore abandoned it. The treatment which I now pursue, is simply to evacuate the matter at the earliest possible period by a moderately free incision, and to wash out the sac most thoroughly with warm water, charged with chlorinated sodium, carbolic acid, or permanganate of potassium, and introduced with a gum elastic syringe. A full anodyne is administered either a short time before or immediately after the operation, and is repeated twice daily for at least one week. The object in giving the anodyne in this way is to prevent undue reaction after the evacuation of the matter, which will otherwise be sure to occur, and to lead to hectic irritation, and great prostration of the vital powers. I was induced to adopt this practice many years ago from observing its beneficial effects in cases of this kind, and can, therefore, warmly recommend it. The medicated injections should be repeated at least twice in the twenty-four hours, the fluid being always thrown into the sac in such a manner as to distend its walls, and thereby promote the thorough cleans-ing of their free surface; in other words, every effort should be made to prevent the accumulation and retention of decomposed and offensive secretions. A drainage tube, of some kind or other, should be retained in the abscess. The best local application, for some time at least, is an emollient poultice or warm-water dressing, medicated with lauda-num and acetate of lead. The patient is kept at rest and supported by tonics, such as quinine and iron, with nutritious food and drink. As the strength improves, exercise is employed in the open air, and advantage taken of a change of air, with, if possible, a residence at the seaside, always so beneficial in exhausted states of the system.

The antiseptic treatment of a scrofulous abscess, through which it is asserted that putre-factive changes in the pyogenic membrane may be prevented, is conducted in the following manner: The skin having been thoroughly washed with a one-to-twenty solution of carbolic acid, a one-to-thirty carbolic spray is directed upon and around it by a steam atomizer, when the abscess is opened freely with a bistoury which has been dipped in a solution of the former strength. When the pus has discharged itself, the lightest pressure alone being permissible to favor its escape, a carbolized drainage tube is inserted, the incision is covered with a bit of oiled-silk protective, and the dressing is completed by retaining upon the part antiseptic gauze, between the seventh and eighth layers of which a piece of mackintosh has been inserted. The first six layers of the gauze, as well as the protective, should be moistened with a one-to-forty carbolic solution before they are applied. The dressing need not be changed for several days unless the occurrence of fever or of profuse discharge demands it. Oil of eucalyptus may be substituted for the carbolic acid, as it is said to be equally as effective as that agent. This method of treatment is still employed by many surgeons, but I regard it as utterly useless.

It has been proposed to open these abscesses while the patient's body is immersed in water, on the ground that there would thus be less likelihood of the introduction of air; but it may well be asked whether the ingress of the former fluid would not be quite as injurious as that of the latter? The truth is, it is hardly possible to perform the opera-tion without some risk of this kind, although, if proper care be taken, the quantity will not be so large as to produce any serious mischief.

As to iodine injections, recommended for the radical cure of this form of abscess, the experience of the profession offers nothing in their favor. The practice, considered in a purely theoretical point of view, is sufficiently plausible, inasmuch as its object is to change the character of the secerning surface of the pyogenic membrane, by inviting an effusion of plastic matter, with the hope of effecting the obliteration of its cavity. It was evidently suggested by the beneficial effects which are known to follow the use of iodine

injections in hydrocele and kindred affections, but to insist upon a similarity of structure of the sac of a chronic abscess and of the vaginal tunic of the testicle certainly evinces a very imperfect knowledge of morbid anatomy. It is not surprising, therefore, that the practice should have failed, and that its employment should have been attended, in most cases, with considerable risk, from its tendency to create undue irritation both in the part and system.

4. HECTIC FEVER.

Hectic fever, although not necessarily dependent upon suppuration, is yet so closely connected with it, as a common result of that process, that it may very properly be described under the same head. Its existence is nearly always indicative of serious organic lesion, of which it, therefore, constitutes merely the general expression. The word hectic, literally signifying a bad habit of body, was originally employed to designate the peculiar train of phenomena attendant upon pulmonary phthisis, of which it forms so remarkable an attribute as to have attracted the attention of practitioners in all ages. It is, however, no longer restricted to such narrow limits; for the group of symptoms which it serves to characterize follows upon a great number of diseases, accidents, and operations, and, therefore, claims the special consideration alike of the surgeon and the physician.

Hectic fever never occurs as an idiopathic affection; on the contrary, it is always symptomatic of some particular disease, generally of the presence of profuse discharge, as of pus or blood, or the existence of an abscess in some important structure, as the brain, lung, or liver. One of the most remarkable circumstances connected with its history is, that it rarely, if ever, appears until the malady which it serves to represent has made considerable progress, or induced serious structural changes, along with grave inroads upon the constitution. Thus, in phthisis, it is seldom witnessed until softening of the tubercular matter is about to take place, sometimes, indeed, not until large cavities have formed; on the other hand, there are cases, as in psoas abscess, where pus frequently exists in large quantity, perhaps for several months, and yet none of the ordinary signs of hectic fever arise. Serious as the local disease apparently is, the general system does not seem to be disposed to take any particular notice of it; the pulse, sleep, appetite, bowels, and secretions all go on nearly in their accustomed manner; and, if there be any loss of flesh and strength, the alteration is so gradual and imperceptible as almost to elude the attention even of the patient himself. But sudden and often most alarming changes occur in the constitution if, in consequence of a large opening, air is freely admitted into the cavity of such an abscess, causing decomposition of its contents. The shock is violent, and resentment of the injury is close at hand; soon a severe rigor comes on, lasting, it may be, several hours, when it is succeeded by violent fever, as this, in its turn, may be followed by copious sweat. Such is not unfrequently the commencement of an attack of hectic fever, a bad habit of body, which often ceases only with the patient's life. Thus, it will be perceived that hectic fever, like every other form of fever, at least so far as we can comprehend its nature and type, is not a disease, but a symptom of disease, an expression of general suffering, dependent upon some special local lesion, not always, perhaps, appreciable by our senses, yet, nevertheless, in active operation, and effectually accomplishing its work.

In traumatic affections, hectic fever often sets in at an early period after the accident; perhaps there may have been grave shock and profuse hemorrhage, and the two are soon followed by copious suppuration, which thus still further undermines and exhausts the vital powers; or it may be that more or less of the pus has been carried into the circulation, and that the whole system has become poisoned by the unfortunate admixture, every blood globule and every fibre and atom of solid matter feeling the baneful influence. The brief struggle which ensues may be characterized by the inflammatory type; but this is evanescent, hectic soon taking its place, and thence on steadily maintaining the ascendency, no intercurrent circumstances ever changing its true character, although they may temporarily disguise it, or for a time keep it in abeyance.

Hectic, then, is a continued, remittent fever, persisting generally so long as the cause which induced it lasts; subject to distinct paroxysms of exacerbation and remission, but at no period, perhaps, completely absent, although apparently it may be. Its outbreak is often sudden and violent, sweeping over the system with the fury of a hurricane; at other times, and more generally, it creeps on gradually and stealthily; in the former case it is marked by severe rigors, in the latter merely by a sense of chilliness, or slight hor-

ripilations.   Whatever may be its mode of attack, its actual invasion is always preceded by more or less indisposition, amounting ordinarily to a mere state of malaise, or a feeling of lassitude and discomfort, which the patient struggles in vain to throw off.   His appetite and sleep are impaired ; his tongue is inclined to be dry, perhaps somewhat coated ; more or less thirst exists ; and there is often considerable fever, either of the inflammatory, irritative, or typhoid type.   In short, hectic, like every other fever, passes through a stage of incubation, brief in one case, protracted in another.   The crisis being attained, the chill appears, and thus the disease is fairly inaugurated; taking its position in the system, which, as already stated, it never abandons until the removal of the exciting cause, and often not then.

The febrile exacerbation is usually vesperal, coming on late in the afternoon, or early in the evening ; lasting, on an average, from six to nine hours, and then gradually going off, to reappear, in a similar manner, about the same time the next day, thus giving the disease a distinct periodical character, not unlike that of an ordinary intermittent.   Not unfrequently there are two paroxysms in the twenty-four hours ; one in the evening, and the other, perhaps, late at night, or during the course of the morning; the latter being generally much the milder of the two.   The chill ushering in the fever is often very long and severe, the patient occasionally shivering for several hours, his teeth chattering violently, and the whole body feeling as if it were wrapped in ice ; at other times, as already intimated, the sensation of cold is very slight, and, perhaps, perceived chiefly along the spine, shoulders, and lower extremities, its duration being variable, now short, now quite protracted.   The chill passing off, reaction succeeds, usually violent in proportion to the previous depression, the temperature, however, rarely exceeding 103.5° Fahr., and gradually, sometimes suddenly, merging into a profuse sweat, the harbinger of returning ease and comfort.   All the secretions are again unlocked ; the mouth regains its moisture ; the urine is poured out in increased quantity ; the thirst rapidly subsides ; the pulse becomes soft and comparatively calm ; and ere long the poor patient, tortured and racked with suffering, falls into a tranquil and refreshing sleep.

In the interval of the paroxysms, the patient, although comparatively comfortable, is by no means entirely free from excitement.   The pulse, in particular, is always preternaturally frequent, often even quick and small ; seldom entirely normal in any case or at any time ; easily disturbed by exercise and mental emotion.   The countenance exhibits well-marked evidence of the inward trouble ; in the morning it is pale, shrunk, and careworn ; in the afternoon, on the contrary, it has generally a somewhat full appearance, and a circumscribed blush, too plainly denotive of the vital decay, rests upon the cheeks in striking and often mournful contrast with the surrounding pallor.   The eyes have a peculiarly lustrous expression, and gradually retreat more and more within their sockets.   Emaciation begins early, and is steadily progressive, proceeding from bad to worse, until the body is literally wasted away to a skeleton.   Amidst all these evidences of decay, it is remarkable how well the appetite frequently sustains itself ; the patient often eats voraciously in the intervals of his paroxysms, and digestion goes on with little or no interruption, assimilation alone being at fault.   The tongue is variously affected ; in general, however, it is clean, or nearly clean, but, perhaps, a little too red at the tip and edges.   At times it is very smooth and glossy ; and cases occur in which it appears to be glazed, as if it were coated with a thin layer of mucus.   A foul tongue is a rare phenomenon in this form of fever.   Hectic patients are usually easily impressed by atmospheric vicissitudes ; the slightest exposure produces chilliness, and hence they always require an unusual amount of clothing.   The feet and legs, in particular, are nearly incessantly cold ; the hands on the contrary are generally dry, hot, and burning.

As the disease occasioning the hectic progresses, the symptoms gradually manifest more and more of a downward tendency ; the appetite fails, the sleep is interrupted, the perspiration is more profuse and exhausting, aphthae appear upon the tongue and fauces, and the bowels are constantly harassed with diarrhœa, the discharges being thin, watery, and excessively fetid.   Thus, the case goes on, steadily but almost imperceptibly, from bad to worse, until the patient dies literally exhausted, by the want of nourishment, and, perhaps, also by the severity of his bodily pains.   During all this struggle, it is astonishing, to see how the mind, rising above the mortal decay around, maintains its supremacy, being not only clear and strong, but hopeful and often even sanguine to the last.

The progress of hectic fever is influenced by such a variety of circumstances as to defy anything like a definite statement.   In general, it promptly disappears with the removal of the existing cause, provided the inroads made by it have not been productive of any serious disorganization ; should this have happened, the case will probably have an un-

favorable issue, the hectic continuing in a modified form down to the fatal crisis. Operative interference often exercises a wonderful influence under such circumstances. I have repeatedly seen a severe and protracted hectic, consequent upon the destruction of a tuberculosed joint, completely vanish in less than twenty-four hours after amputation, and the system rapidly recover from the effects of the previous disturbance.

The indications in the treatment of hectic fever plainly are, first, to remove the exciting cause, and, secondly, to support the system until it has an opportunity of shaking off the effects of the morbid action.

The first of these objects is frequently best accomplished by the knife, as when, for example, the disease depends upon, and has been kept up by, a tuberculosed joint, or a suppurating compound fracture, the removal of which often promptly restores health and tone to the prostrate system. If the cause be inaccessible, the case must be treated upon general principles, in the hope that, by and by, as the strength improves, the patient will have sufficient recuperative power to dislodge the source of irritation, and so get rid of his malady.

The second indication is fulfilled by tonics, nutritious food, anodynes, the suppression of unnatural discharges, change of air, and attention to cleanliness.

The use of tonics is generally indispensable in almost every case of hectic, however induced, particularly in its more advanced stages, when there is a wretchedly impoverished condition both of the blood and solids. The articles most to be relied upon are quinine, aromatic tincture of bark, and the different preparations of iron, of which, according to my experience, the sulphate and the tincture of the chloride deserve the preference. Whatever substance be selected, its operation should be aided by a nutritious diet, consisting of the richer kinds of animal broths, beef-essence, beefsteak, milk-punch, tapioca, arrowroot, and milk, whine whey, ale, or porter. When the emaciation is steadily progressive, and dependent upon a tubercular diathesis, cod-liver oil will be of service, and should be given in as large doses as the stomach may be able to bear.

Anodynes are among the most valuable agents in the treatment of hectic, as they serve to allay the inordinate action of the heart, to relieve pain and irritation, and to procure sleep, which is generally so much impaired in cases of this kind. They should be given in full doses, not too often repeated, the best period for their exhibition being usually towards bedtime, so that their appropriate effects may be realized during the night in refreshing tranquility. Morphia is generally better borne than opium, but when there is much sweat or diarrhœa, it may often be advantageously replaced by the latter, as more likely to produce an astringent influence.

The exhausting effects of diarrhœa and perspiration, especially when they are of a colliquative character, must be promptly counteracted by suitable remedies, of which opium, as just stated, is one of the best. When the diarrhœa is dependent upon vitiated fecal matter, a mild laxative should be given, and blue mass, or calomel, in minute doses, if it has been caused by derangement of the biliary secretion. Sometimes it is most readily checked by astringents, as rhatany, prepared chalk, or tannic acid, in union with an anodyne.

Night sweats, often a source of so much prostration, are best controlled by the free use of aromatic sulphuric acid, tannate of iron, oxide of zinc, or atropia, with frequent ablutions of the surface with tepid alum water. Atropia is especially valuable in controlling night sweats. It may be given by the mouth, in the dose of the fiftieth to the sixtieth part of a grain, or, what is preferable, in the form of a hypodermic injection, the average being the one-hundredth part of a grain. The injection need rarely be repeated oftener than once in twenty-four hours. Sometimes the sweats may be effectually prevented by a full opiate administered a short time before the expected rigors.

When the local disease, inducing the hectic, admits of it, exercise should be taken in the open air, which frequently conduces more to the restoration of the patient's appetite and strength, and the relief of the colliquative diarrhœa and sweats, than all other means combined. Children may be carried about in their nurses' arms, or in the hand car, while adults may ride about in a carriage, or walk, as may be most agreeable and convenient. Occasionally a residence at the seaside will be found to be eminently beneficial.

Finally, cleanliness is of the greatest possible importance; the body must be frequently washed and rubbed; the excretions carefully and promptly removed; and the apartment thoroughly ventilated at least twice a day, the windows being lowered in the mean time to admit of a constant supply of fresh air.

SECT. V.—SEPTICEMIA AND PYEMIA.

By septicemia is meant a febrile affection which is produced by the absorption of putrid material into the blood, and which is not accompanied by the development of metastatic abscesses. The term pyemia, on the other hand, is restricted to the fever which is caused by the entrance of septic material into the circulation, where it multiplies and gives rise to embolic abscesses. Both affections are frequently associated with each other, and pyemia is merely septicemia with the addition of certain inflammatory lesions.

Before entering into the separate consideration of these septic fevers, a brief sketch of the nature of the septic poison, which is the same in both affections, and of its mode of absorption affords an interesting field of inquiry. Gaspard, of St. Etienne, in France, as early as 1808, performed an elaborate series of experiments with putrefying fluids, with a view of ascertaining their effects upon the system when introduced under the skin or into the veins of animals. He found that, when the quantity was considerable, it invariably induced violent constitutional symptoms, attended with great gastric distress, and copious fetid and bloody alvine evacuations, rapidly followed by exhaustion and death. These researches were published in 1822, in Magendie's Journal of Physiology, but attracted little or no attention on the part of scientific men. During the past twenty years, however, the experiments of Weber, Billroth, Burdon-Sanderson, Koch, Hueter, Savory, Davaine, and others, have fully verified the results established by Gaspard three-quarters of a century ago, and have supplied us with a few additional facts, chiefly in reference to the existence of certain microscopic organisms in the blood and tissues during the progress of septicemia and pyemia, of which the French observer was ignorant. The septic poison, upon the introduction of which into the circulating blood these specific fevers depend, usually originates in connection with the putrefying secretions of surgical wounds and injuries, in which minute rod-like and spherical organisms, known respectively as bacteria and micrococci, are always present, and which are considered by many observers as being essential for the production of the infective material. Some writers assert that the bacteria are the active agents in the pathogenesis of septicemia, pyemia, puerperal peritonitis, and allied affections; while others, again, maintain that the micrococci are the important factors. Billroth and Hallier deny that these organisms are distinct; Klebs doubts it; but Cohn, Rindfleisch, and Cheyne affirm that specific differences exist between them. During the past seventeen years, mainly through the exertions of Mr. Lister, the attention of surgeons has been directed to the prevention of the entrance of these schizomycetes into wounds from the surrounding atmosphere, with a view of avoiding decomposition of the discharges, and thereby averting local and general inflammatory processes. That the introduction of these low organisms into the system from putrefying surfaces occasions the septic fevers is strenuously asserted by Pasteur, Lister, Sanderson, Birch-Hirschfeld, Hueter, Koch, and other distinguished observers; but that they are essential to their development is by no means proved. If it be true that microscopic organisms are the cause of the evils that have been ascribed to them, the micrococci must be regarded as being utterly harmless, since numerous examinations of the discharges of wounds treated antiseptically, conducted by Ranke, Volkmann, Cheyne, and others, demonstrate that they almost invariably contain these bodies, and that they multiply rapidly in weak solutions of carbolic acid. Then, again, if the septic poison is a product of the growth of bacteria, and if the septic fevers arise from the direct action of the bacteria on the system, those affections should not be produced by the injection of putrid fluids from which the bacteria have been removed by filtration through porcelain. Numerous experiments of this nature have conclusively shown, however, that the effects of the poison are not due to the organisms themselves. Hence, other investigators have looked for some other infective material, and have concluded with Panum, Bergmann, and Billroth, that there exists in decomposing fluids a soluble chemical product termed sepsin, to the absorption of which septicemia and pyemia may be attributed.

The intimate nature of the poison of septicemia and pyemia is entirely unknown. The probability is that it is similar to, if not absolutely identical with, the poison of traumatic or surgical fever, erysipelas, hospital gangrene, puerperal fever, and kindred affections. Obstetric physicians long ago noticed that a bad form of septicemia is often produced during pregnancy by the presence in the womb of a dead fœtus. The juices of a decomposing child being absorbed by the uterus, and carried into the system, give rise to the very worst form of the affection, characterized by great gastric irritability, high temperature, great restlessness, offensive alvine evacuations, delirium, and excessive prostration, followed, in a few days, by death. It has been remarked, in such cases, that the amni-

otic liquor and the vaginal discharges are often almost insupportably offensive. When such fluids are permitted to enter the system, whether they contain bacteria and micrococci, or are free from these organisms, they must invariably give rise to a septic fever of the very worst form, and this is precisely what the results of obstetric practice have fully established.

To sum up my own views of the nature of the septic poison, I may state that I believe that the infective material is sepsin, or the chemical product of the decomposition of the tissues, and that the schizomycetes, which have been shown to be present in the blood and organs of septicemic and pyemic animals and men, as well as the corpuscles of putrefying blood and pus, act merely as carriers and disseminators of the poison.

Whatever the nature of the poison may be, one thing is perfectly certain, and this is that it is frequently, if not generally, highly inoculable. Of this fact the results of the experiments above referred to, and of surgical experience, private and hospital, afford indubitable evidence. Many lives have been lost from the effects of wounds and punctures in examining the bodies of persons dead of septic affections; and every obstetrician is painfully familiar with the inoculable character of the secretions furnished during the progress of puerperal fever. The poison in such cases often adheres to the fingers and even to the clothing, despite the utmost attention to cleanliness, and is thus readily carried from one person to another.

The poison gains admission into the system through the lymphatics and the veins, but more especially through the former vessels, and its absorption is effected most readily when the putrid fluid is in contact with a fresh wound, or with a serous or synovial cavity. A point of great practical interest is that healthy granulations, in which most careful examinations have failed to discover the presence of lymphatics, afford a decided protection against septic absorption; but if they are unhealthy or are destroyed they present a surface which readily admits decomposing fluids.

1. SEPTICEMIA.

From the experiments, principally of German observers, which have been carefully considered by the committee appointed by the Pathological Society of London to investigate the nature and causes of pyemia, septicemia, and purulent infection, and whose report may be found in the thirtieth volume of its Transactions, it appears probable that septicemia includes two distinct conditions, which are known, respectively, as septic or putrid intoxication, and septic or putrid infection.

In regard to the former condition, which may be termed toxemia, experiments upon animals demonstrate that if a lethal quantity of putrefying material is injected under the skin death rapidly follows simply from the effects of the chemical poison termed sepsin. The blood injected into another animal does not set up a similar affection, thereby showing that the poison does not multiply in that fluid; nor does the blood, according to the observations of Koch, contain minute organisms, although it undergoes certain changes, of which the most important are, first, the tendency of the red corpuscles to aggregate into small masses instead of rouleaux, and, secondly, the commencing disintegration of the corpuscles, as shown by the staining of the serum with the blood pigment, and the occurrence of petechiæ beneath the serous membranes. The other post-mortem appearances indicate intense congestion of the gastro-intestinal mucous membrane, and engorgement and softening of the spleen. The clinical phenomena which accompany these morbid changes are elevation of the temperature to $104°$ Fahr., and upwards, with corresponding increase in the frequency of the pulse, unrest, muscular twitching, gravescent muscular debility, oppressed breathing, vomiting, profuse diarrhœa, somnolence, and coma.

In the human subject a mild form of septic intoxication is of very common occurrence in connection with severe surgical injuries and wounds, to which the term traumatic or surgical fever is usually applied. The committee already alluded to consider that the conditions under which acute septic intoxication can occur in man comprise the admission of a considerable quantity of putrid matter, as from one to two ounces, rapidly absorbed from large, irregular recent wounds, from serous or synovial cavities, from large abscesses opening externally by an insufficient aperture, and from the raw surface of the uterus left by the separation of the placenta. After the operation of ovariotomy the conditions most favorable to septic intoxication are all present, and many deaths occurring in the first two days are doubtless referable to it. The conclusions of the committee in regard to the evidence to be looked for as indications of acute putrid intoxication in man are, first, " the presence of a sufficient quantity of septic matter to yield the necessary dose of

the septic poison; secondly, the invasion of the symptoms at a time when decomposition of the discharges has commenced, and before the surface of the wound has become covered by granulations; thirdly, high fever rapidly followed by great depression; fourthly, post-mortem appearances indicative of a tendency to congestion and capillary hemorrhage; and, lastly, the absence of organisms from the blood during life, or immediately after death."

In the second form of septicemia, or septic infection, which may be termed ichorrhemia, the poison multiplies in the system, and a drop of the blood or of the inflammatory discharges sets up a similar process in another animal. The blood, moreover, in addition to changes which are met with in septic intoxication, contains large numbers of bacteria; and the lungs, spleen, and liver are congested. The disease develops more slowly and pursues a more chronic course than acute putrid intoxication, and the symptoms are fever with progressive emaciation and exhaustion. The distinction between the two affections is obscure; but infective septicemia may be suspected to exist when from the small size of a wound it is impossible for a lethal dose of septic matter to be formed in it; and the evidence of infection from one patient to another is conclusive when it exists, as it cannot occur in cases of pure septic intoxication. As the clinical distinction between these two forms of blood-poisoning cannot, in the present state of our knowledge, be accurately made, the remaining remarks will refer simply to septicemia as distinguished from pyemia.

In the majority of cases the signs of septicemia begin on the second day, the disease being ushered in by a marked chill, which is followed by febrile excitement, during which the temperature varies from 103° to 108° Fahr., but rapidly subsides during the succeeding sweating. When the affection assumes a severe type, the more prominent symptoms, in the order of their frequency, in addition to muscular weakness, are delirium, an icteric tint of the skin, dyspnœa, vomiting, diarrhœa, and ecchymoses of the integument. In the milder cases the temperature reaches its maximum of 103° or 104° Fahr., in from two to four days, and then sinks with the development of suppuration, and gradually disappears with the formation of healthy granulations.

Attempts have been made to draw a distinction between septicemia and pyemia by the chills, which are said, as a rule, to be limited to the initial rigor in the former, and to succeed one another in a few hours or days in the latter affection. In septicemia they are repeated, however, more than once in four-fifths of all cases, so that this feature is of no diagnostic value. A high temperature is more characteristic of septicemia, and it does not appear to be the subject of the irregular variations of pyemia, which range as high as 10° or even over 10° or 11° Fahr.

The principal lesions found in patients dead of septicemia are congestion of the lungs, parenchymatous swelling and softness of the spleen and liver, extreme congestion and ecchymoses of the gastro-intestinal mucous membrane, subserous petechiæ, and post-mortem staining of the tissues. The blood is not uncommonly very fluid, and early decomposition is occasionally witnessed. The prognosis of the affection is most unpromising. In the fatal cases, although life is now and then prolonged for three weeks, one-half perish in four days from the commencement of the invasion, and four-fifths in the first eight days. The treatment does not differ from that of pyemia.

2. PYEMIA.

The fact that certain injuries and operations are occasionally followed by the development of abscesses in some of the internal organs of the body, did not escape the attention of some of the older surgeons. Ambrose Paré makes distinct mention of the occurrence; and Pigrai, about the same period, noticed that, during one particular year, nearly every person who was so unfortunate as to have a wound of the head, died of suppuration of the liver. These observations were afterward confirmed by Morgagni, Bertrandi, and Andouillé, and, more recently, by Schmucker, Kern, Klein, Hennen, Larrey, Guthrie, and other military surgeons, as well as by many hospital and private practitioners. Velpeau, however, was the first to investigate the lesion in a really scientific manner, and to institute a thorough and elaborate examination into its etiology, pathology, and treatment.

Although the exciting causes of pyemia are of a very diversified character, the most important, by far, are shock, loss of blood, or depression of the vital powers. As following severe injuries of the head, it was, as already stated, long ago noticed by many of the older pathologists and surgeons, although they failed to offer any correct or even plausible theory of its occurrence. Since attention was first prominently called to it, in

1823, by Velpeau, it has been much oftener observed after compound fractures and dis-locations, lacerated, contused, railway, and gunshot wounds, and amputations of the larger limbs, than after any other accidents.   In lying-in females it is also sufficiently frequent. and is, in fact, a considerable source of the mortality consequent upon the puerperal state.   It has been known to supervene upon erysipelas, carbuncle, periostitis, necrosis, diseases of the joints, injury of the big toe, gumboil, abscess of the throat and middle ear, smallpox, scar-latina, typhoid fever, ulcerative endocarditis, suppurative myositis, and even gonorrhœa. One of the first cases of the disease I ever saw occurred in a young woman laboring under a slight attack of erysipelas of the leg.   On dissection, I found the cause of death to have been a pyemic abscess in the left lung, about the volume of a large almond, filled with aplastic matter, and surrounded by highly inflamed and softened tissue.   No appreciable disease existed in any other part of the body.   The secondary purulent collections so often met with in glanders and dissection wounds evidently belong to this class of affections.   Pyemia occasionally succeeds to the use of the trephine, the extirpation of tumors, and operations on the bones, joints, urinary organs, and bloodvessels.   Sometimes, indeed, apparently the most trifling operation is followed by it.   Many years ago I attended, in consultation, a man who lost his life by blood-poisoning consequent upon bleeding at the bend of the arm ; and a similar case afterwards occurred in my own practice at the Louisville Marine Hospital.   The patient, a colored woman, the subject of chronic disease of the wrist-joint, was bled at the median basilic vein.   In a few days violent phlebitis super-vened, followed by large purulent collections in nearly all the principal articulations, as well as among the muscles of the arm and shoulder, terminating fatally in less than a week.   The injury inflicted in the removal of a small piece of dead bone has been known to cause death by embolic abscesses.   In 1848, I lost a young man, twenty-eight years of age, from pyemia, induced by tying three hemorrhoidal tumors.   Death occurred on the eighth day ; and, on dissection, the connective tissue of the mesorectum was found to be studded with hundreds of abscesses, from the size of a currant to that of a small pea.

Pyemia occasionally follows the suppurative inflammation consequent upon a badly-healed stump, weeks, if not months, it may be, after the amputation, and long after the patient is apparently out of danger.   The discharge, perhaps never entirely arrested, suddenly increases in quantity, the parts become tender and irritable, the constitution is seriously affected, rigors soon set in, and, in short, all the symptoms of blood-poisoning are fully declared.

The disease, now and then, assumes an endemic type.   Thus, in the military hospital at Stanton, during the late war, fifty-nine cases, all, excepting two, the result of gunshot injuries and surgical operations, occurred within a period of twelve months.

No period of life is entirely exempt from this disease.   It has been met with even in children at the breast ; and a case has been reported of an infant, only ten days old, in whose body, the subject of erysipelas, not less than nine large abscesses of this kind had formed, causing death in a short time.   On the other hand, it occasionally occurs at a very advanced age.   Young and robust subjects, however, have appeared to me to be most liable to it, especially after severe railway, gunshot, and other accidents, attended with severe shock and excessive loss of blood.   Wounds of, and operations upon, the veins are very prone to be followed by blood-poisoning.   Pyemia is more common among the inhabitants of crowded cities than among those who enjoy the benefit of pure country air, good wholesome food, and an abundance of exercise and sleep ; it is likewise more frequent in hospitals, almshouses, and other receptacles for the poor, than in private practice ; circumstances of no little interest, both in an etiological and therapeutic point of view.

Unhealthy occupations, exposure, fatigue, loss of sleep, and mental anxiety are powerful predisposing causes of pyemia.   It is asserted by Mounier that during the war in the Crimea not a single case of this disease occurred among the first two thousand amputations, while it was afterward very common in association with gangrene, scurvy, typhoid fever, and other low states of the system.

With regard to the immediate cause of pyemia, the old notion that it is the product of metastasis, or, in other words, that it is due to the absorption of pus from the part originally affected, and to the transportation of this fluid to some other, more or less remote, situation, where it is collected into a focus, and thus becomes a source of new irritation and disease, has still its advocates and adherents.   It rests upon the supposition that the pus corpuscles are admitted, unchanged, into the open mouths of the veins at the seat of the wound, as, for example, the surface of a stump after amputation, and that, being so introduced into the circulation, and pushed onward by the blood, they are finally

arrested in the minute capillaries, which are unable to transmit them, as they do the red particles of the blood, in consequence of their lager size. The mechanical obstruction thus occasioned forms, it is alleged, a new cause of morbid action, which is soon followed by the development of an abscess, or a deposition of pus, and, if the new depots be numerous, by purulent infection. In opposition to this doctrine, it has been contended that pus corpuscles never gain access in this way into the circulation, and that those who profess to have seen them there were deceived by the resemblance which these corpuscles bear to the colorless globules of the blood. Moreover, it has been clearly shown that the injection of laudable pus does not induce symptoms which resemble those of pyemia in any respect, but merely gives rise to a transient fever.

The doctrine that pus, as such, cannot enter the circulation has been completely overturned by the observations of modern pathologists, who have demonstrated the permeability of the walls of the veins and capillaries to colorless blood corpuscles, or their equivalents, pus corpuscles, which would render the view of the direct introduction of pus into the blood as a factor in the production of pyemia, at least plausible. In the event of pus corpuscles—pathologically altered colorless blood corpuscles—finding their way into the blood through the softened walls of the vessels of the inflamed part, it is, however, scarcely probable that they would give rise to the formation of abscesses in the manner described in the preceding paragraph, since the tendency of the commingling of the two fluids would be to the production of a clot or thrombus, which would form, as will be pointed out below, the first link in the chain of morbid action. I have myself no doubt whatever that pus, as pus, may enter the blood, and give rise to septic changes in that fluid, and, further that, under certain circumstances, it may lead to the formation of an initial thrombus, to the retrograde changes in which the phenomena of pyemia are partly due.

Passing over other theories which have been advanced from time to time as to the causation of pyemia, it is evident that under the term pyemia should be included three distinct and dissimilar processes, changes in the blood, the formation of septic thrombi and emboli with metastatic deposits, and the absorption of ichorous or putrid fluids, which may coexist in the majority of cases, and are possibly interdependent. The modifications of the blood consist of an increase in the number of colorless corpuscles, with simultaneous increase of the fibrin. The tendency of these elements is to cohere and to form adherent layers upon the inner walls of the vessels, points which not only favor the occurrence of stasis, but also, by presenting centres of roughness, invite more or less extensive coagulation of the blood. It is in this way that the changes in the blood become one of the causes of thrombosis.

The connection of thrombosis and embolism with the formation of metastatic, or embolic, abscesses is one of the most interesting, as well as one of the most firmly established, facts in pathology. A thrombus or clot may form, in a vein, 1st, in consequence of the retardation or interruption of the current of blood, due commonly either to constriction of the vessel, from the compression exerted upon it by the products of the inflamed perivascular tissues, or to the division of the vessel, as, for example, in an amputation, whereby the flow of blood is completely cut off; 2dly, to inflammation of the coats of the veins themselves, the result of very acute inflammation of the connective tissues around them; and, 3rdly, to projections into the lumen of the vessels caused by small abscesses in their walls, or adherent layers of fibrin and white blood corpuscles, due to leucocytosis, or small offsets of fibrin, which are merely the central ends of thrombi formed in the smaller veins, where they communicate with the branch or trunk affected, or colonies of schizomycetes, which line the larger vessels and project into them in the form of papillae. All of these conditions form starting points for larger coagula, which afterwards increase by the deposition of successive layers of fibrin.

The disposition of a fully formed thrombus will depend upon the quality of the fibrin and the nature of the inflammation. If the fibrin be organizable and the inflammation tend to resolution, the thrombus will be converted into connective tissue and cause simple obstruction; but if the morbid action proceed to suppuration and gangrene, the clot will soften, disintegrate, and break down into a puriform fluid, which, mingling with the fibrinous detritus, excites phlebitis, as shown by thickening of, and the occurrence of purulent deposits in, the walls of the vessel, and the partial destruction of its coats.

The central end of the thrombus generally extends to the nearest collateral branch, where it projects into the main trunk, by the addition to it of layers of fibrin, as exhibited at *a*, fig. 17, from Callender. Under the influence of predisposing causes, most probably the septic condition of the blood, the clot softens, particles, fragments, or emboli are loosened and detached by the current of blood, as at *b*, and carried into the circulation,

until the right side of the heart is reached, whence they pass into the pulmonary arteries, in the smaller ramifications of which, and usually at a bifurcation, they are arrested. At the points of lodgement they excite inflammation, which terminates in suppuration and sloughing of the walls of the vessels and of the parenchymatous perivascular tissues, and, in this way, give rise to the so-called metastatic abscesses. In other cases, the embolus is so large as to deprive a portion of the lungs of their due supply of blood, causing in this event gangrene of the points involved. From these primary pulmonary abscesses venous thrombi form, which, in their turn, reach the left side of the heart; and through the systemic circulation develop similar phenomena in the liver, spleen, kidneys, subcutaneous tissue, and other structures. The explanation of those rare cases of secondary abscesses in organs, when the capillaries of the lungs have escaped, is probably to be found in the hypothesis that thrombi disintegrate into particles or granules, which are so minute as to enable them to slip by the pulmonic system of vessels into the left side of the heart.

Fig. 17.

Formation and Softening of Venous Thrombi.

The third process concerned in the development of pyemia, and that which, in all probability, occasions the disintegration of the thrombi, is a poisoned state of the blood, systemic infection, ichorrhemia, or septicemia, consequent upon the absorption of the ichorous, septic, or putrescent material present in suppurating and gangrenous wounds and in stumps after amputation. Not only may the more watery portion of the noxious secretions enter the circulation, thoroughly contaminating both solids and fluids, and, consequently, effectually undermining the constitution; but, as I previously stated, the corpuscular elements may permeate the walls of the vessels, and by their mechanical action upon the blood, excite the formation of thrombi.

The researches of the committee appointed by the Pathological Society of London, to whose labors allusion is made in the preceding section, render it highly probable that pyemia frequently depends upon a general infective process, which is rapidly followed by the development of abscesses without the formation of thrombi. Thus, of 156 fatal cases, in 58, or 37 per cent., there was no evidence whatever that the abscesses and suppurations discovered in the viscera and elsewhere were due to thrombo-embolic processes. In the remaining 98 cases, on the other hand, the disease could be traced to putrid embolisms. In the latter class the poison does not multiply in the system, and it has not been shown experimentally that the affection is communicable by means of the blood from one animal to another. In view of these facts the committee are disposed to separate pyemia, as they did septicemia, into a non-infective and an infective form, the latter being a specific and a communicable disease, whereas the former does not possess those attributes, but is merely a condition of blood-poisoning from the absorption of septic material from putrefying wounds. The first link in the chain of pyemia from traumatism thus appears to be an altered condition of the blood, attributable to a depressed and enfeebled state of the constitution engendered principally by loss of blood, severe shock, or a tainted state of the atmosphere; the second, the formation of abscesses, which are usually found in connection with thrombosis and embolism; the third, systemic infection due to the absorption of noxious matter.

These views of the causes of pyemia derive the strongest possible confirmation from the experiments of Polli and other observers upon animals, proving, as they incontestably do, that unhealthy pus thrown into the blood produces septicemia with multiple abscesses; and, secondly, that the injection of putrid substances gives rise to a bad form of suppuration characterized by symptoms of typhoid gastro-enteritis. Virchow had previously induced all the conditions of pyemia by the introduction of a piece of putrid fibrin into the jugular vein of a dog.

The prejudicial effects that are exerted by the emanations from the wounds of pyemic patients upon the wounds and constitutions of healthy subjects confined in the same apartments, as, for instance, in the crowded wards of a hospital, are well known to military as well as civil practitioners, and they necessitate the greatest possible care in the management of such cases, in order to prevent the extension of disease. A poison of the most subtle and virulent character is engendered in the foul air thus produced, probably similar to that of hospital gangrene, and exceedingly destructive to all those who are brought under its baneful influence. Under these circumstances schizomycetes are gene-

rally developed in great numbers upon wounds and sores, and, in hospitals, may sometimes be discovered upon the floor, walls, and ceilings.

Is pyemia, as the name denotes, always a result of the admission of vitiated secretions, or of putrescent matter into the circulation? Instances occur, as when the disease complicates typhoid fever, scarlatina, and various other asthenic affections, where the reverse would seem to be the case, and yet, it must be confessed, it is not always possible, even here, to determine whether the individual is entirely free from antecedent suppurative action. It is probable that, under such circumstances, mere disorder of the blood, such as undoubtedly attends the worst forms of these maladies, may be quite adequate to the production of secondary abscesses of a very bad character.

The period of latency of pyemia is commonly very short, not exceeding a few days from the time of the accident or operation giving rise to it. There are cases, however, although they are infrequent, in which a much longer time elapses. In every 100 cases the symptoms appear in the first week in 57, in the second week in 19, and after a fortnight in 24. As a general rule, it may be assumed that the briefness of the period of latency will be in proportion to the shock of the system, the amount of hemorrhage, and the ill state of the patient's health prior to the injury. The time is usually shorter in traumatic than in idiopathic affections, in the latter of which the secondary lesion occasionally does not come on until near the period of apparent convalescence.

The approaches of pyemia are generally very stealthy and insidious; hence the young and inexperienced practitioner is often thrown completely off his guard in respect to the nature of the formidable disease with which he has to grapple. If, for instance, the attack is one consequent upon an amputation, he probably feels concerned to find that the stump gives evidence of being in an unhealthy condition, that it is unusually tender and painful, that it manifests no disposition to heal, and that the discharge is not only profuse, but foul, thin, sanious, bloody, or ichorous. The patient, although not inclined to complain much, is restless and ill at ease, looking pale, sallow, and anxious, as if some serious evil were impending. His pulse is irritable and too frequent, the cheek is marked by a sinister flush, the appetite is impaired, the secretions are deranged, and there is a remarkable increase in the temperature of the body. This prodroma is of short duration, often hardly lasting twenty-four hours. Rigors, more or less violent, now set in, and having continued from fifteen minutes to several hours, are succeeded by excessive reaction, and this, in turn, by profuse sweats, often completely drenching the surface and even the body clothes. These rigors may return twice or even thrice in the twenty-four hours, or they may come on at regular periods, not unlike the paroxysms of an intermittent fever, for which the unwary sometimes mistake them. Their severity is not always the same; cases occur in which they are replaced, as it were, by chilly sensations, alternating with flushes of heat, and not unfrequently lasting for several days together. In 27 per cent. of all instances they are absent altogether, and when this happens they are replaced by profuse sweating. In whatever manner this outbreak displays itself, the disease at once assumes a more bold and decisive character. The skin and conjunctiva exhibit a well-marked icterode appearance; the features are shrunken and withered, the nose being pinched and the eye sunk in its socket; the pulse is small, feeble, and frequent, usually ranging from 100 to 120, although it may reach nearly 200; the breathing is accelerated, ranging from 40 to 50 in the minute, and performed with unusual effort; the tongue is hard, dry, and brown; the thirst is urgent; the sleep and appetite are interrupted; the bowels are irregular, being at one time relaxed, and at another constipated; the stomach is irritable and nauseated; the urine is high-colored and scanty; the extremities are cold; the mind wanders; and the body is often racked with excruciating pain, especially in the joints and muscles, which are not unfrequently exquisitely sensitive to the slightest touch. Occasionally the patient complains of severe pain in some internal organ, to which he refers all his principal suffering. Cough is sometimes present, and is then generally dependent upon more or less serious lesion of the pulmonary tissues, or of the lung and pleura. As the disease progresses, red blotches, swollen, and excessively painful, appear upon the larger joints, and serve as the forerunners of approaching suppuration in their interior, as well as in the tissues immediately around them. Similar marks occasionally occur in the course of the principal veins and in the situation of some of the muscles, particularly the deltoid and pectoral. In some of the more obscure forms of pyemia, the chief evidence of the disease is an eruption of the skin, as the erythematous, vesicular or pustular, or an erysipelatous condition of certain portions of the surface, very liable to be mistaken for some other affection.

There is always in pyemia a notable increase in the temperature of the body which, at

the commencement of the chill, rapidly and constantly rises, and attains its highest point at its termination, when it may reach even 108° Fahr. It is, however, subject to irregular variations, which range over 10° or 11° Fahr. During the sweating stage the temperature again falls to its former level.

The symptoms, long before the disease has reached this crisis, are of a typhoid character, the whole system seemingly laboring under the depressing influence of a deadly poison. The downward tendency is rapidly progressive; the machinery of life moves alternately to and fro; the pulse becomes more and more feeble; the respiration is frightfully oppressed; the body is remarkably emaciated; and the patient lies in a comatose condition, from which he is destined never to awake. This, however, is not uniformly the case; for the instances are not infrequent, where the mind retains its consciousness almost to the last. The average period at which death occurs, after the disease has fairly commenced, varies from ten days to a fortnight, the minimum being a few days, and the maximum, as nearly as can be determined, about three months. In every 100 cases, 42 die in the first week, 30 in the second week, 20 in the third week, and 8 after the thirtieth day. Of the more prominent symptoms the most common, in the order of their frequency, are rigors, delirium, vomiting, diarrhœa, rapid emaciation, and jaundice.

Although there are, strictly speaking, no pathognomonic symptoms of pyemia, it is seldom that any one who has ever seen a case of this disease, or who has made himself thoroughly familiar with its history and progress, can possibly confound it with any other complaint. Its very mode of invasion generally sufficiently stamps its true character. The sudden, violent, and unexpected rigor, usually followed by copious sweats; the extraordinary increase of temperature; the unhealthy character of the suppurating sore or wound, if any exist; the icterode and shrunken state of the features; the rapid supervention of typhoid symptoms; the great mental anxiety and excessive restlessness; the horrible aching pains in the joints, limbs, and other regions; and, lastly, the rapid abduction of the fat, leaving the body in a wasted and emaciated condition, far beyond what occurs in almost any other affection, excepting, perhaps, cholera; are signs which, if they do not unerringly mark the nature of pyemia, will always excite the serious suspicion of the attendant, and induce him to scrutinize the case in the most careful and thorough manner. Almost the only disease with which blood-poisoning is liable to be confounded is intermittent fever; but here the distinction is so easily drawn as to render error impossible. Pyemia of the joints has sometimes been mistaken, especially in its earlier stages, for acute articular rheumatism, rheumatic gout, or rheumatoid arthritis. The diagnosis of traumatic pyemia is generally less difficult than that of the idiopathic variety, or that arising from internal causes, the violent rigor, the icterode countenance, and the rapid prostration and emaciation being usually sufficiently characteristic of the nature of the complaint.

The dissection of patients dead of pyemia reveals important and interesting changes both in the solids and fluids. Of those affecting the solids, the most constant are abscesses and purulent depots in various organs, cavities, and tissues. The former, generally known under the name of *metastatic*, embolic, or multiple abscesses, are most common in the lungs, next in the liver and spleen, and, lastly, in the kidneys, brain, and heart. They sometimes occur in the subcutaneous connective substance, and beneath the peritoneum. In one instance, previously referred to, I found an immense number in the connective tissue of the mesorectum. Their presence has also been detected in the prostate and parotid glands.

Professor Sédillot, of Strasbourg, who has studied this disease with great care, remarks that in 100 cases the lungs would be likely to be affected in 99; the liver and spleen in 1 of 12; the muscles in 1 of 15; and the heart and peripheric connective tissues in 1 of 20. Of 131 cases analyzed by the committee of the Pathological Society, abscesses were found in the lungs in 104, in the liver in 14, in the spleen in 11, in the kidneys in 9, in the brain in 6, in the heart in 3, and in the subcutaneous connective tissue in 6.

Metastatic abscesses vary in number in different instances from one to twenty, thirty, fifty, or even several hundreds. Occasionally, indeed, the surface of the affected organ is completely studded with them, more than a thousand having been observed in a single case, principally in the deep-seated viscera. Their size ranges from a hemp-seed or a pea to a hazelnut, a marble, a pigeon's egg, or even an orange. When very numerous, they are usually proportionately small. In their form they are oval, spherical, or angular. When seated near each other, they are occasionally confluent, like the pustules of smallpox.

The contents of metastatic abscesses seldom consist of well-formed pus; on the contrary, the matter is usually of a semi-concrete consistence, of a dirty grayish, cineritious,

or drab color, and largely intermixed with spoiled lymph. It further differs from genuine or healthy pus in the absence of the true nucleated pus corpuscles, and in the existence of an unusual quantity of oily matter and immense numbers of granular cells, and low organisms. When the abscess is more matured, or when it is of long standing, the contents are more decidedly purulent, but even then there is frequently a very considerable amount of foreign substance, as flakes of fibrin, grumous blood, and the debris of the affected tissues. In pyemic suppuration of the serous membranes, the fluid that is so abundantly secreted by these structures consists mainly of turbid serum, or puriform matter; while in the joints it is of an oily or greasy character, of a pale yellowish hue, and destitute of well-formed pus corpuscles and nucleated cells.

The textures immediately around the abscess may be natural, or variously altered in appearance and consistence. In most cases they are engorged with blood, heightened in color, and more or less softened, if not completely pulpified. The coats of the vessels are inflamed, thickened, and infiltrated with serosity, while their canals are filled with pus, semifluid blood, emboli or fibrinous concretions. The capillary veins and arteries usually participate in the inflammation. The blood always contains an unusually large quantity of fibrin and white corpuscles.

Purulent collections, as a consequence of pyemia, are most common in the chest, being rare in the peritoneum, the arachnoid, and pericardium. The reason of this difference seems to be that the lungs nearly always suffer when there is serious involvement of the system, whereas the abdominal viscera, heart, and brain usually escape.

The joints often suffer very severely. In some of the cases that I have had an opportunity of examining after death, matter was found in nearly all the larger ones, and also in quite a number of the smaller. Very frequently the pus is situated on the outside of the joints, as well as within.

Large collections of purulent fluid sometimes occur in the subcutaneous and intermuscular connective tissue, the result evidently of cellulitis; the veins also occasionally contain a considerable quantity, either lying free in their cavities, or, as is more common, intermixed with the blood in the interior of fibrinous concretions.

The pus that is found in these various localities is of the same nature as the fluid contained in metastatic abscesses, properly so termed, that is, it is imperfectly elaborated, and intermixed with a large proportion of aplastic material. Both in the veins and in the intermuscular connective tissue, it is generally, as just stated, interspersed through fibrinous concretions, coagula, or blood-clots, giving the latter a peculiar appearance, as if they were infiltrated with small specks of lymph, or lymph and pus.

In addition to abscesses and purulent collections, the most common lesions met with in pyemia are parenchymatous swelling of the spleen, kidneys, and liver, congestion of the lungs, and subserous petechiae. Internal congestions are, however, less frequent than in septicemia.

The prognosis of pyemia is most unfavorable; few patients recover, and these, for the most part, remain for a long time in a debilitated and crippled condition, liable to outbreaks of other diseases from the slightest causes. Of forty cases, mostly gunshot fractures, treated at the Lettterman Hospital after the battle of Gettysburg, not one was saved. Of 150 cases analyzed by Dr. William S. Savory, of London, 26 recovered, but this is an unusual percentage. The fatal character of the disease is well illustrated in the cases that occurred in the Stanton Hospital, fifty-nine in number, of which, according to the statement of Dr. Lidell, only three recovered, affording thus a ratio of mortality of nearly 95 per cent. Most of the patients died before the tenth day, and two in less than forty-eight hours, only one surviving a month. As already stated, death usually occurs within the first fortnight of the attack, apparently from the severe exhaustion consequent upon the excessive pain and obstructed circulation, so conspicuous in this affection. A return to health is generally announced by the presence in the urine of an unusual quantity of lithic acid and by the gradual subsidence of the graver symptoms.

Treatment.—In the treatment of pyemia the leading objects should be, first to remove the exciting cause of the disease; secondly, to eliminate the poison from the system; and, thirdly, to support the constitution, in order to enable it, if possible, to shake off the toxical influence under which it is so plainly laboring.

If the disease has been induced by an accident or operation, attended with an open, suppurating surface, much may be done, in many cases, by the promotion of cleanliness and the use of antiseptics, to prevent further mischief from the ingress of purulent fluid. This object is best attained by diligent, almost incessant, attention to the dressings and to the position of the part, the former being frequently changed, and the latter so arranged

as to favor the escape of the secretions as fast as they are poured out. Detergent lotions are often serviceable, especially if they contain chlorinated sodium, carbolic acid, or chloride of zinc, but care must be taken that they are not so strong as to irritate; and it will be well, particularly if the surgeon has to deal with a foul stump, to throw them freely upon the parts with a large syringe, as this exerts a much better and wider influence than the less efficient irrigation with a sponge. It will also be advantageous to keep the dressings constantly sprinkled with the chlorides, both with a view of allaying fetor and of purifying the air of the apartment, which must be frequently renewed by opening the doors and windows.

To prevent the further ingress of purulent fluid into the system is not so easily accomplished. If the surface is not too extensive, the best remedy will be the officinal solution of acid nitrate of mercury diluted with four to ten parts of water, applied rapidly and freely with a mop, the intention being not so much to produce an escharotic as an alterant effect, thereby inviting a rapid change in the action of the capillary vessels and an abundance of exudation matter, so as to close up the mouths of the vessels, and cause consolidation of the affected tissues generally. When the vessels are large and patulous, they may sometimes be closed by well-regulated methodical compression. The actual cautery, recommended by the French surgeons for sealing the suppurating surface, should never be employed, unless it be drawn over the parts, previously well wiped, in the most careful and considerate manner.

To neutralize the poison of pyemia, or to render it inoperative, is an object of vital importance in the treatment of the disease, and yet, if such a remedy exist, it remains to be pointed out. The hyposulphites of sodium, potassium, and ammonium seem to have yielded good results in some cases, in the hands of Polli, T. Spencer Wells, Dr. Walter F. Atlee and others, and they are worthy of further trial, as they exert a direct influence upon the blood and the tissues during the time that it is necessary to convert them into sulphates, the form in which they are eliminated from the system. To produce the desired effect, the medicines should be given in large and sustained doses.

The third and last indication is best fulfilled by stimulants and tonics, as brandy, wine, ammonia, camphor, iron, and quinine, with animal broths, and other suitable means of support. Opiates should be given freely to allay pain and induce sleep. The recurrence of rigors, or chilly sensations, is most readily prevented by quinine and morphia, the dose of the former being not less than ten grains to one-third of a grain of the latter, every four or six hours, until a decided impression has been made upon the system. No benefit can accrue, under such desperate circumstances, from administering these articles in smaller quantity, as they only serve to tease the system, and to permit the play of morbid affinities. The irritability of the stomach, so often present in pyemia, is generally best controlled by sinapisms, abstinence from drink, the use of ice, and the exhibition of aromatic spirits of ammonia, champagne, or lemon-juice neutralized by bicarbonate of potassium. Bromide of potassium, either alone or in union with hydrate of chloral, often acts very beneficially under such circumstances. When dependent upon the lodgement of bile, or vitiated ingesta, a gentle emetic may be of service, as ground mustard and common salt. Active purging must be avoided.

Inflammation of the joints and muscles must be treated with soothing measures, as warm medicated lotions and cataplasms, aided by the frequent application of iodine. If abscesses form, evacuation must be afforded by early and free incisions, the opening being made in such a manner as to prevent accumulation and bagging of fluids. Determination to internal organs, as the lungs, heart, spleen, and liver, must be counteracted by dry cupping and blistering. The secretions, generally so much disordered in pyemia, should be corrected with blue mass or calomel, not carried so far as to provoke ptyalism, as this could not fail to prove prejudicial.

Bleeding, both local and general, is invariably inadmissible in all diseases attended with blood-poisoning. The system, oppressed and borne down by the toxical influence, needs all the support it can derive from this fluid; the whole current, it is true, is vitiated, and its vitality greatly impaired, but, although this is the case, no sensible practitioner would attempt to improve the condition of the affected part by such a procedure. Good nourishing food and drink, with invigorating medicines, alone can be confided in under such circumstances, when the loss of even a small quantity of blood would inevitably hasten the fatal crisis.

When a marked tendency to hemorrhage exists, in consequence of a dissolved and broken-down state of the blood, the most suitable remedies will be some of the preparations of iron, especially the tannate and tincture of the chloride, the former in doses of

five to ten grains, and the latter of twenty to twenty-five drops, every three or four hours. The same remedies, either alone or combined with ergot and atropia, will generally answer for arresting the copious sweats so often present in the different stages of pyemia. Sometimes acids, as the nitric and sulphuric, may advantageously be exhibited, with a view both to their tonic and to their antidiaphoretic effects.

Throughout the whole treatment, great attention must be paid to cleanliness; the bed and body clothes should be frequently changed, the surface of the patient sponged with tepid salt water, or weak chlorinated washes, and the apartment constantly ventilated, fresh air being more essential to recovery than all other means combined. In all cases the most rigid observance of hygienic measures will be required to insure ultimate restoration. Convalescence will always be tardy, and the slightest exposure, fatigue, or irregularity of diet will be certain to endanger life.

SECT. VI.—HEMORRHAGE.

A discharge of blood, as an effect of inflammation, is an uncommon occurrence. It may take place in the interstices of the organs and tissues, or upon their free surfaces, and is generally a result of the rupture of some of the vessels of the part, in consequence of the manner in which the blood is sent into them by the heart, at a time when their walls, weakened by the morbid action, are incapable of offering much resistance. It is probable that, when the blood is in a dissolved condition, as occasionally happens in scurvy, typhoid fever, and other low states of the system, the hemorrhage may occur as a product of secretion, or, rather, perhaps as a mechanical transudation, the fluid percolating through the coats of the vessels as water oozes through a bladder, the globules passing off in an altered and disintegrated form.

The fluid may present itself in a pure state; or, as is more generally the case, be mixed with other morbid products, as serum, lymph, pus, and mucus, which may thus essentially modify its properties, if not, in a great degree, mask its character. The quantity of the effused blood varies, in different cases and under different circumstances, from a few drops to a number of ounces. The largest hemorrhages of this kind commonly occur in connection with the serous and mucous surfaces, and the subcutaneous and intermuscular connective tissue, especially in diffuse erysipelas, and in inflammation consequent upon snakebite, in the latter of which the dissolved state of the blood powerfully predisposes to the extravasation. In scorbutic affections, where a somewhat similar condition of the fluid exists, inflammatory hemorrhages are by no means infrequent. Considerable effusions of blood occasionally take place in the air-cells of the lungs and the minute bronchial tubes in pneumonitis. In dysentery, a discharge of blood and mucus is one of the characteristic symptoms of that disease.

Inflammatory hemorrhage rarely comes on until the action of which it is a product has made considerable progress; hence its appearance may generally be regarded as denotive of a higher grade of excitement than a mere deposit of serum, plasma, or even pus. When the discharge is copious, it may, if it do not go too far, prove serviceable in the way of depletion, answering much the same purpose as local bleeding by leeching, scarification, or puncture. In general, however, it is too small to confer any substantial benefit in this way; while, on the other hand, if it be very copious, it may speedily lead if not to fatal exhaustion, at all events to such a degree of depression as to interfere materially with recovery. Besides, it may cause serious mechanical obstruction, as when it is effused into the interstices of organs, thus sadly impeding their functions.

In the treatment of inflammatory hemorrhage reliance is to be placed mainly upon the ordinary antiphlogistic measures, employed more or less vigorously according to the exigencies of each particular case. If the discharge be at all copious, so as to threaten exhaustion, recourse may be had to the administration of acetate of lead in union with opium, and injections of the same article, or, what will be better, of the subsulphate of iron, a substance which possesses a remarkably controlling influence over all kinds of capillary bleeding, whether inflammatory or otherwise. They must, however, be used with great caution, that they may not excite undue irritation. Sometimes the discharge may readily be arrested by cold applications, as cloths wrung out of iced water, and frequently renewed, or by the steady employment of a bladder partially filled with pounded ice, or some refrigerating lotion. When the blood has been poured out into the connective tissue beneath the skin, or among the muscles, and acts injuriously by compressing the capillary vessels, nothing short of early and free incisions will be likely to avail. When the hemorrhage is internal, proceeding from a serous membrane, as the pleura or perito-

neum, the use of sorbefacient remedies is indicated ; but these failing, as they will be likely to do, when the deposit is uncommonly large, evacuation must be attempted with the trocar, although such an operation will generally be extremely hazardous, not to say anything of its inefficacy when the effused blood has undergone coagulation, thus rendering its escape impracticable.

SECT. VII.—MORTIFICATION.

Mortification may be defined to be the death of a part, the rest of the organism retaining its vitality. The word, as now usually employed, is synonymous with gangrene, which was formerly used to denote that state of a part which immediately precedes its dissolution, while sphacelus was employed to signify the complete extinction of life, without any possibility of its recovery. In speaking of the death of a bone, necrosis is the expression generally adopted.

Mortification may be acute or chronic, moist or dry, common or specific, according to the rapidity of its progress, the condition of the dead part, or the nature of the exciting cause. There is really no material difference between acute and moist mortification, or between dry and chronic, and hence these terms may very properly be employed in a convertible sense. The word specific implies the operation of a peculiar virus in the production of the death of a part, as the poison of the rattle-snake, of chancroid, or of malignant pustule.

1. ACUTE MORTIFICATION.

Acute mortification, whether the result of traumatic or idiopathic causes, may occur in all parts of the body, with, perhaps, the sole exception of the heart. There are some organs and tissues, however, which possess this tendency in a much greater degree than others, or which, more properly speaking, are better adapted to withstand its assaults. It may be stated, as a rule, that those textures are most prone to perish, which stand lowest in the scale of organization, or which have naturally a feeble life. Hence the fibrous membranes, tendons, ligaments, cartilages, and bones commonly perish very readily, and often to a great extent. The connective tissue is also very liable to suffer, its areolar structure fitting it in a very special manner for the reception of morbid products, the pressure of which, inducing mechanical obstruction in its vessels, is a frequent cause of mortification in erysipelatous and other forms of inflammation. When the supply of blood is cut off from the skin, by the infiltration of the cellular substance beneath, this structure also dies very readily, notwithstanding its wonderful nervous and vascular endowments. Next in order come the mucous and serous membranes, the lymphatic glands, muscles, nerves, and bloodvessels, the latter of which, especially the larger trunks and branches, generally perish very reluctantly, as is proved by the fact that they often retain their vitality in the midst of the sphacelated parts, as, for example, occasionally happens in malignant scarlatina, attended with mortification of the glands and connective tissue of the neck.

Mortification of the internal organs is very uncommon. In the lungs it is occasionally a consequence of pneumonitis. It is likewise noticed, but still more rarely, in the liver, spleen, kidneys, uterus, and ovaries. The testicle, mamma, tonsils, and salivary glands sometimes perish from the effects of erysipelas, and the prostate from urinary infiltration. Of mortification of the heart no well-authenticated instance is upon record. Gangrene of the brain, from wounds of its substance, although infrequent, is occasionally witnessed.

The *causes* of acute mortification are the same as those of acute inflammation ; whatever has a tendency to produce the one may occasion the other. It is not necessary, therefore, to enter into any minute discussion respecting them. They may be divided, in reference to their character, into five distinct classes: 1. Intensity of inflammatory action. 2. Mechanical obstruction of the circulation. 3. Chemical agents. 4. Defect of nervous energy. 5. Constitutional debility.

I. It has already been seen how *intensity* of inflammation acts in producing obstruction in the capillary vessels of the affected part ; how the blood, rendered adhesive by the increase of fibrin and white globules, attaches itself to their walls, and how these walls, softened and dilated, at length yield under the pressure of their contents, which are often, in consequence, extensively effused into the surrounding tissues, thus materially aggravating the local trouble. As the disease progresses, the capillary engorgement rapidly augments, the blood becoming more and more stagnant, and there is also almost complete suspension of the nervous fluid. In short, the greatest perversion of structure and func

tion exists, the part is in an utterly helpless condition, circulation and innervation are entirely at a stand, and death, already actively engaged at the focus of the inflammation, soon accomplishes its work.

Mortification from intensity of action generally advances at an alarming rate, a large amount of tissue, and sometimes even an entire limb, perishing in the course of twenty-four hours from the commencement of the process. Some of the most characteristic forms of this species of gangrene are met with in compound fractures and dislocations, in lacerated, contused, railway, gunshot, and poisoned wounds, in burns and scalds, in carbuncle, and erysipelas, in which the tissues often succumb under the resulting inflammation with amazing rapidity. Hence, such cases, of which fig. 18 affords an excellent illustration, are generally said to be acute ; and, as the parts are always inundated with fluids, the term " moist" is also often used to designate them.

Fig. 18.

Acute Mortification, Rapid in its Progress, and attended with much Swelling and Moisture.

II. Mortification from *mechanical obstruction* of the circulation may be caused by direct injuries to the arteries, or indirectly through disease of the heart, interrupting the flow of blood to the part. Ligation of the femoral artery for the cure of aneurism of the popliteal, is occasionally followed by mortification of the foot and leg ; and a similar accident sometimes happens from the pressure which a tumor of this kind exerts upon the terminal branches of this vessel. The circulation being thus impeded, inflammation, generally of a very active kind, is liable to be awakened, which soon overpowers the affected tissues. Laceration of the principal artery of a limb often results in the death of the structures which it supplied with blood. Disease of the valves of the heart, leading to vascular engorgement of the feet and legs, along with œdema of the subcutaneous connective tissue, not unfrequently produces similar effects. Tight bandaging, pressure of the body from protracted decubitus, and inordinate constriction of the bowel, in strangulated hernia, are so many causes of mortification from interruption of the circulation.

Gangrene is sometimes produced by obstruction of the arteries by *emboli*, either detached or adherent, or detached clots. Instances of cerebral gangrene, from this cause, have been witnessed by different observers ; and Paget has collected the particulars of seventeen cases in which it gave rise to mortification of the lungs. The influence of the puerperal state in favoring the formation of fibrinous concretions has long been familiar to pathologists. Gangrene of the extremities from detached cardiac clots, or emboli, is sufficiently common. A very interesting case of this form of mortification was kindly shown to me some time ago by Dr. James H. Hutchinson, of this city, in a girl, eleven years of age, who had long been affected with disease of the heart, attended latterly with considerable anemia. Gangrene of the foot and leg set in early in March, and terminated fatally on the 13th of April following, a line of demarcation having previously formed two inches below the knee, and the foot dropped off near the ankle. The limb, at first of a mottled, livid aspect, ultimately became perfectly dark, and was all along the seat of the most intense pain. The heart was found to be dilated and hypertrophied, the mitral valve greatly contracted, the left auricle distended with an old grumous clot, and the right common and external iliac arteries completely obstructed by a firm concretion.

Embolism occasionally induces mortification with astonishing rapidity, as in a case, communicated to me by Dr. Leonard, of a child six years old, who, while seemingly in good health, was suddenly seized with excessive prostration, accompanied with delirium, unconsciousness, and great depression of the temperature of the whole body. In a short time the left leg became livid, and the next morning the foot was found to be dead as high up as the ankle, the surface being black, dry, cold, and insensible. At the end of a week

a line of demarcation began to appear, and, amputation being performed below the knee, the case resulted in a good recovery.

Gangrene from embolism sometimes arises during the progress of typhoid and other fevers. In a case reported to be by Dr. Edward North, the patient, a lad, twelve years of age, while convalescing from an attack of the former of these diseases, was suddenly seized with mortification of the foot, which gradually extended to the leg, along the course of the anterior tibial artery to within four inches of the knee. After amputation of the limb, the cause of the mischief was found to be a clot completely occluding the popliteal artery. A similar case has been communicated to me by Dr. T. H. Andrews. Dr. Walter F. Atlee attended a woman, forty-eight years of age, who, while apparently in sound health, was seized with thrombosis of the femoral artery, ending in gangrene of the leg, followed by death on the sixth day from the attack.

Mortification occasionally arises from obstacle to the return of venous blood. The occurrence is most common in the lower extremities as an effect of valvular disease of the heart, and is generally preceded as well as accompanied by great œdema. When the morbid action is unusually severe, the skin is of a dull red, purple, or livid aspect, from congestion of the subcutaneous vessels, pits freely on pressure, and is the seat of a burning, throbbing pain. Vesicles, of variable size and shape, filled with turbid serosity, form upon the inflamed parts, and, upon bursting, the exposed surface is found to be of a dark red or brownish hue, partially, if not completely, devitalized, cold, and insensible. The mortification usually occurs in small, superficial patches, particularly over the tibia and about the ankle, the skin eventually dropping off in pale, grayish, or ash-colored sloughs.

The sudden loss of a large quantity of blood, in a person of intemperate habits or depraved constitution, sometimes induces mortification. A drunken man, whose case has been reported by Sir B. C. Brodie, was seized, soon after having been bled to an inordinate extent, with gangrene of both feet, doubtless due to embolism.

III. The influence of *chemical agents* in producing inflammation and mortification is exemplified in various ways. The contact of the alkalies and acids, if very slight, will generally cause merely a rubefacient effect; if more severe, it will induce vesication; while in its worst form it will occasion instantaneous destruction of the tissues. Heat and cold act very much in the same manner. In all these cases life is destroyed, either by the primary impression of the chemical agent, or by the violence of the resulting inflammation. In persons of feeble organization, especially, in young children impoverished by starvation and disease, the application of a common blister is often followed by extensive sloughing; and a similar effect is occasionally witnessed as a consequence simply of the protracted retention of a mustard plaster. The infiltration of urine in the connective tissue of the perineum often produces wide-spread gangrene of the scrotum; and portions of peritoneum sometimes perish from the contact of bile and feces.

Although nothing definitely is known of the nature of animal poisons, it is highly probable that they induce inflammation and gangrene much in the same way as the acids and alkalies. Some of these poisons are the product of a peculiar secretion with which the animal is provided as a means of defence; others, on the contrary, appear to be developed by a peculiar septic action, which is particularly strong during the last moments of life, and for a short time afterwards, before the tissues have undergone much decomposition. However generated, their entrance into the circulation usually awakens a peculiar form of inflammation, which not unfrequently terminates in the death of the affected structures; often with extreme rapidity, as, for instance, in snake-bite, chancroid, and malignant pustule.

IV. Defective *nervous power* is an occasional cause of mortification. A palsied limb, for example, is much less capable of resisting the influence of ordinary physical agents than a sound one, and, when inflamed, the morbid action is much more liable than usual to terminate in mortification. In apoplexy and injury of the spinal cord, attended with lesion of innervation, the most trifling puncture, nay, even the application of a blister, is sometimes followed by the death of the part. The occurrence of bad bed-sores, from the same cause, is a matter of daily observation. The division of the peroneal nerve, in the removal of a tumor of the leg, has been succeeded by mortification of the small toes; and Magendie, long ago, ascertained that, if the ophthalmic branch of the fifth pair of nerves be cut within the cranium, the resulting inflammation will end in sloughing of the cornea.

V. The occurrence of mortification from *general debility* is well illustrated in typhoid fever, scarlatina, measles, smallpox, and scurvy, as well as in other states of the system, attended with loss of innervation, and an impoverished condition of the blood. During the progress of these diseases, local inflammation, however induced, is extremely liable

to assume a bad type, and to terminate finally in mortification. In typhoid fever, extensive sloughs often form upon the hips and the sacrum, despite all the attention that can be bestowed upon the patient in warding off pressure ; and in scarlatina and other eruptive maladies, mortification of the neck and throat is by no means uncommon from an inflammation, which, ordinarily, would readily resolve itself in a few days, but which, now that the system is exhausted by the operation of the peculiar poison of these affections, is promptly followed by the death of the part. Inflammation of an organ, set up immediately after the occurrence of profuse and debilitating hemorrhages, is very liable to eventuate in the same disastrous manner. Mercury given in low states of the system, to the induction of ptyalism, often leads to violent sloughing of the gums and cheeks, and to necrosis of the jaw and teeth, followed by the most horrible disfigurement of the features.

A form of mortification of the jaws has long been known among operatives engaged in the manufacture of lucifer matches, from the pernicious effects of phosphorus. How this substance produces this result is still a mystery. It is supposed by some that it makes its impression locally ; by others, that it acts through the constitution, in the same manner very much as mercury.

When acute inflammation is about to terminate in mortification, there is generally a sudden aggravation of all the previous symptoms, both local and constitutional. The pain and sensibility become more keen and intolerable, the redness assumes a more vivid aspect, the swelling and tension materially increase, effusion is unusually active, and functional disorder is at its maximum. If sores or wounds exist, all discharge generally ceases. Along with these local phenomena, there is marked augmentation of the constitutional trouble ; the fever is excessive, the pulse is frequent and often quite strong, the thirst is intense, and there is great restlessness, commonly with more or less delirium. The type of the constitutional symptoms exhibits much diversity. In young and robust individuals it is generally of a sthenic character, or denotive of strength ; but, when the disease has been unusually violent, or the system has sustained a serious shock, whether from the present attack, or from previous suffering, it is commonly indicative of prostration, the tongue and mouth being dry, the pulse frequent and feeble, the stomach irritable, and the surface bathed with cold, clammy perspiration.

The complete cessation of vitality, in mortification of an external part of the body, is denoted by the livid, black, or mottled discoloration of the skin ; by all absence of heat and sensibility ; by a peculiar fetid or cadaverous odor ; and by more or less crepitation, from incipient decomposition. Immediately beyond the seat of the mortification the ordinary phenomena of inflammation are notably visible ; the surface is of a scarlet or purplish hue, hot, dry, tumid, and painful, and the dead and suffering structures are usually insensibly blended, or separated merely by a faint, indistinct line.

The part having actually died, the general symptoms are no longer of an equivocal character, whatever they may have been during the previous struggle. They are now clearly of a typhoid nature, and, consequently, fully denotive of the exhausted condition of the system. The pulse is small, feeble, and one hundred and forty to one hundred and sixty in a minute ; the surface, bathed with cold, clammy sweat, has a yellowish, withered appearance, and exhales a peculiarly disagreeable odor, not unlike that of moist earth ; the respiration is short, hurried, and difficult ; the countenance is pale and shrunken ; the eyes are devoid of lustre and sunk in their sockets ; the nose is thin and pinched ; the lips are incrusted with dark scabs ; the tongue is dry, contracted, and covered with a thick blackish fur ; the abdomen is tympanitic ; and there are frequent twitchings of the tendons, with hiccough and low, muttering delirium. The strength is so much exhausted that the patient, unable to sustain himself upon his pillow, constantly sinks down in the bed ; the stomach is harassed with nausea, or nausea and bilious vomiting ; and towards the last there are often involuntary discharges from the bowels, with retention of urine.

The cause of this depressed condition of the system is probably twofold. In the first place, it may be supposed to depend upon the shock which such an occurrence must necessarily inflict upon the great nervous centres ; and, secondly, upon the absorption of vitiated matter, which, by its union with the blood, contaminates both solids and fluids, thereby incapacitating them for the discharge of their appropriate functions, in short, a poison is developed similar to that in septicemia.

The color of the mortified parts varies in the different organs and tissues. The skin, as already remarked, is usually purple, black, or mottled, while the connective tissue beneath it, in great measure, retains its normal complexion, unless, as sometimes happens, it has been infiltrated with bloody matter, when it will, of course, be of a dark, reddish, or modena color. The aponeuroses, muscles, tendons, nerves, vessels, cartilages, and bones

undergo very little change in this respect. In mortification of the lungs, the color is black; of the brain, grayish or ashy; of the liver, reddish or yellowish. The serous membranes are commonly of a lilac or purplish tint; the mucous, of a black, brownish, or claret, with almost every possible intermediate shade. As a general rule, it may be assumed that the depth of color of the sphacelated structures is in direct ratio to their vascularity and the violence of the antecedent action.

The consistence of the dead part is also variable; in general, it is quite soft, and, as it were, broken down, from the infiltrated condition of the connective tissue and of the inter-molecular spaces of the proper structures of the affected organ. In mortification of the limbs, involving all the compound tissues, the part feels swollen, soft, and crepitant, because it contains both gas and different kinds of fluids, as serum, pus, and blood; but, if the textures be examined individually, it will be found that all, with the exception of the connective, are very nearly of their normal consistence, particularly if there is as yet but little decomposition. In the parenchymatous organs, as the brain and lungs, the loss of cohesion is always very great, the mortified mass being of a soft, pultaceous consistence.

The fetor in mortification is peculiar and characteristic. It evidently depends upon the extrication of sulphuretted hydrogen gas, and is sometimes, as in mortification of the lungs, almost insupportable.

The effects of mortification upon the general system vary with many circumstances; they may be so severe as to destroy life in a few days, or even in a few hours, as occasion-ally happens in the traumatic form of the lesion; or, on the other hand, so slight as to be hardly felt even as a serious inconvenience. In the latter case, an attempt is generally made, after some time, to detach the dead parts from the living, by the establishment of ulcer-ative action, the first evidence of which is the formation of a circle of vesicles, usually filled with

Fig. 19.
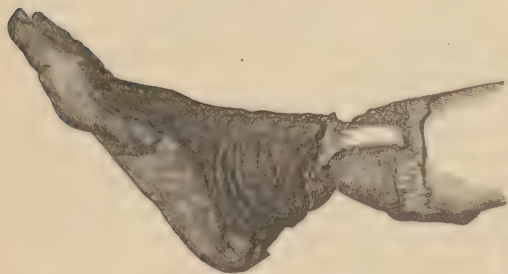
Mortification of the Foot and Leg with an Appearance of the Sloughing Process, the Soft Parts being Extensively Separated from the Bone.

a sero-sanguinolent, ichorous, or turbid fluid. Presently these vesicles burst, and then a faint reddish line is observ-able, known as the line of demarcation, which, as it is denotive of the cessation of the gangrene, is always looked for with great anxiety by the attendant. The process, which constitutes a species of natural amputation, seen in fig. 19, often proceeds with considerable rapid-ity, one part separating after another, generally skin and connective tissue first, then muscle, next tendon and aponeuro-sis, then vessel and nerve, and lastly cartilage and bone; the latter being always detached with extreme difficulty, on account of the large quantity of earthy substance which it contains. Owing to this circumstance, several months commonly elapse before the connection is finally severed, and even then the proceeding is anything but surgical, the stump thus made being always badly shaped and but rarely covered with an adequate amount of integument.

The separation of the dead parts is always accompanied with more or less pain, dis-charge, and fetor, adding thus still further to the prostration of the system, and the danger of constitutional contamination. The pain is sometimes excessive, while at other times it is very trivial, depending upon the extent of the morbid action, and the state of the constitution. In general, it is sharp, stinging, smarting, or burning. The discharge, which is often very profuse, is always, at first, unhealthy, ichorous, or sanguinolent, and irritating; by degrees, however, it assumes a more favorable character, and at length acquires all the properties of laudable pus. The fetor is generally sickening, and over-powering; tainting the atmosphere of the apartment, and unless speedily corrected, ex-erting a most prejudicial effect upon the patient. The emanation is, of course, rather from the dead parts, now called a slough, than from the gap, or trough, which lies between them and the living. As the separation progresses, granulations gradually spring up along the raw border, exhibiting the usual appearances of healthy bodies of this kind in other situations, and furnishing an abundance of thick, yellowish pus, which, while it serves to shield them from the rude contact of the air, affords the surgeon excellent oppor-tunity of judging of the nature of the ulcerative action, or, in other words, of the state of the part and system.

While these changes are going on between the dead and living parts, for the riddance of the former, and the benefit of the latter, all the ordinary phenomena of inflammation are plainly visible in the structures above or around the breach, nature being busy in throwing up her walls of defence by pouring out a liberal supply of plastic matter into the meshes of the connective tissue. In this way the surviving structures are solidified and fortified against the ingress of air, and also, at least in some degree, against the absorption of pus and ichorous fluid.

The manner in which the vessels are closed in mortification, so as to prevent hemorrhage during sloughing, is worthy of passing notice. As was before stated, both the arteries and veins possess an astonishing conservative power, by which, at least in many cases, they are enabled to maintain their vitality in the midst of the dead and perishing structures. At length, however, they also yield to the devastating influence, but not before their contents have become thoroughly coagulated and firmly adherent to their inner walls, thereby hermetically sealing their orifices. Hence, no bleeding can occur; and for the same reason there is often no hemorrhage whatever during the artificial section of the part, inasmuch as the clots of blood frequently extend a considerable distance beyond the line of demarcation.

Treatment.—The treatment of acute mortification is conducted upon the general principles applicable to that of inflammation. When this event is about to occur in a person of strong, robust habit, with a vigorous pulse, and a red, fiery, and painful condition of part, the indication is to draw blood by leeching, if not also by venesection, to make free use of depressants, along with a sufficiency of opium to allay pain and quiet the heart's action, and to cover the affected surface with a large blister, to paint it with iodine, or to keep it constantly wet with saturnine and anodyne lotions, either tepid, cool, or cold, as may be most agreeable. When the local action is accompanied with inordinate swelling, punctures, scarifications, or incisions should be made, freely and early, in order to afford vent to effused fluids, to relieve congestion, and to moderate pain and tension. The approach of gangrene may often be averted, certainly materially checked, by the timely use of a blister, large enough to cover in not only the whole of the inflamed part, but also a portion of the healthy skin, and retained sufficiently long to effect thorough vesication. I am satisfied, from observation, that there is generally no more efficient remedy. It is particularly valuable in the idiopathic form of the disease, although it is not without its benefit in the traumatic. I was first led to use it from its great efficacy in erysipelas, where it unquestionably very frequently averts the occurrence of gangrene altogether; and it is well known to the American surgeon that it was a favorite means, in this affection, in the hands of Physick. Cantharidal collodion is a valuable substitute for the blister, as it accommodates itself better to the parts, and is much more prompt in its action.

When mortification has actually occurred, our line of conduct must of course be different from what it is when we are watching its approaches. The symptoms may still be of a sthenic nature, as will probably be the case when the patient is young and robust, and the part invaded is of trifling importance to life. Nevertheless, it will hardly be proper, even then, to indulge in further depletion, certainly not in venesection; leeching may be admissible, and we may perhaps continue, in a moderate degree, the internal use of antiphlogistics; cautiously and warily, however, lest they be instrumental in bringing on premature exhaustion, and thus placing life in jeopardy. When, on the contrary, the patient is feeble, the pulse small and frequent, and the tongue already covered with a brownish fur, clearly denotive of an asthenic state of the system, stimulants and tonics must be employed, and, in fact, every effort made to husband the remaining powers of the constitution. The best remedies then are quinine, tincture of iron, camphor, and opium, alone or variously combined, together with wine whey, pure wine, or what is far better than either, brandy, gin, or whiskey. The diet must be as nourishing and concentrated as possible, so that, while it affords the greatest amount of sustenance in the smallest space, it may not oppress by its weight and bulk. The most reliable articles are beef essence and the different kinds of animal broths, aided, as the appetite and the digestion improve, by tapioca, sago, broma, corn starch, oysters, beefsteak, and poultry, which are then commonly well borne by the stomach. The most potent internal remedies, properly so called, are quinine and iron; full doses of opium, to allay pain and procure sleep; and brandy, in the form of milk-punch. Little, if any, confidence is to be placed in the carbonate of ammonium, musk, castor, and valerian, so much vaunted by some of the older writers, and still occasionally exhibited by modern practitioners; these articles possess no blood-generating power, and rarely do much good even as nervines. The system,

in such a state, requires something more active and permanent, and there are no means so well calculated to fulfil this indication as those just mentioned.

Whatever measures, of a general nature, be adopted, the utmost attention must be paid to cleanliness and ventilation. Sponging the surface several times a day with tepid salt water, or, if there be much perspiration, with a strong solution of alum, will be highly beneficial, if not carried to fatigue ; the body and bedclothes must be frequently changed ; and the windows should either be kept constantly open, or be often raised, in order to secure the admission of pure air, so essential to the healthful reaction of the system in disease.

The object of the local treatment is to allay fetor, which is generally so excessive in acute gangrene, and to promote the rapid separation of the sloughs. The first of these measures is best accomplished by the liberal use of permanganate of potassium, the chlorides, or Labarraque's disinfecting liquid, sprinkled freely upon the parts, as well as upon the body and bedclothes ; the second, by the steady application of fermenting cataplasms, or the warm-water dressing, simple or medicated. The charcoal poultice, formerly so much in vogue in such cases, is now seldom employed, as it discolors and obscures the inflamed surface, and thus conceals its true condition. The ordinary yeast poultice is, on the whole, as eligible an application as can well be made ; where an additional stimulant is required, recourse may be had to camphor water, chlorinated sodium, chloride of zinc, or some of the acids, as the nitric, pyroligneous, and, above all, the carbolic, diluted with from twenty to forty parts of water ; pieces of lint wet with any of these fluids being laid in the gap, and kept in place by the cataplasm.

When the sloughs are tardy in separating, the knife and scissors are employed, with care, of course, in making the dissection, not to interfere with the living tissues, much less with any important vessels. For want of due precaution in performing this little operation, much suffering is sometimes entailed, and I have witnessed several cases in which the patient was absolutely destroyed by it ; for, when the powers of life are greatly reduced by the effects of the gangrene, the most insignificant bleeding and the most trifling shock may prove fatal.

Clearance having been effected of the dead and putrid mass, the next object is to promote the granulating process, by the steady use of emollient and soothing dressings ; aided, if necessary, by weak lotions of acid nitrate of mercury, nitric acid, nitrate of silver, or acetate of zinc, of balsam of Peru, tincture of benzoin, creasote, and similar articles. The system must be supported by suitable tonics, nourishing food, and change of air. As soon as the granulations begin to assume a healthy aspect, as indicated by their florid color, and the thick, yellowish character of the discharges, the healing process will generally progress best under the most simple dressings, serving merely as protectives against friction and rude exposure ; as, opiate cerate, or a light emollient poultice. If the sore be large, cicatrization may be promoted by touching its edges lightly once a day with solid nitrate of silver, and drawing them gently together with adhesive strips. Skin-grafting will often greatly expedite the cure.

In connection with this subject the question of *amputation* necessarily arises. Under what circumstances is this operation necessary or proper ? Should it be performed while the mortification is still progressing, or postponed until it is completely arrested, and a line of demarcation is formed ? These are important points, and they should, therefore, always be duly considered ; for it is the solemn duty of the surgeon to save not only the life, but also, if possible, the limb of his patient. To preserve, not to mutilate, should be the object ; since it is a thousand times more creditable to his skill and judgment to save one extremity than to lop off a hundred, however adroitly this may be done.

In attempting to settle this question, special reference must be had to the nature of the mortification, or the causes under the influence of which it is developed ; for experience has shown that the two forms of the disease generally require different treatment. Thus, in idiopathic gangrene the rule is never to amputate until the surgeon is assured, by the establishment of a circle of demarcation, that both the part and system are in a condition to bear the shock of the operation, and that death has been completely arrested. Even further delay may be demanded, if, upon careful investigation, it be found that the patient is still feeble from the effects of the mortification ; that he looks pale and wan ; that he has a weak and shattered pulse ; in short, that everything is denotive of an exhausted state of his constitution. To amputate under such circumstances would greatly endanger the result, if not positively destroy the patient ; proper allowance must also be made for the loss of blood and the shock which must of necessity follow the use of the knife, both of which, even when the greatest care is taken in performing the operation,

are often most serious. If, on the other hand, the powers of the system are sufficiently active, if there is no apparent contamination of the fluids and solids, and, above all, if nature is making a vigorous effort to arrest the extension of the malady, there is no reason for delay, and therefore the sooner the offensive parts are removed the more likely will the case be to have a favorable termination ; the system is prepared for the emergency, and will soon react from any depression that may ensue from the employment of the knife. Longer delay, in truth, should not be thought of, seeing what pernicious influence the retention of the dead structures must by their putrid and fetid condition exercise upon the system, already weakened to a sad extent by the disease before the tissues were fully deprived of vitality.

From this treatment that of traumatic gangrene is altogether different ; here the extinction of vitality is usually more rapid and extensive, and hence to wait always, or even generally, for the appearance of a line of demarcation, would be virtually, in many cases, to consign the patient to the grave without making an effort to rescue him from the impending danger. When injury of an important artery, nerve, or joint is the cause of the mortification, amputation can hardly be performed too soon ; nothing, certainly, can be gained by delay, which, even in a few hours, may put the case beyond our reach, such, not unfrequently, is the swiftness with which death travels along the affected limb. This is particularly liable to happen in railway, factory, and steamboat accidents, which are so common in this country, and which are often of the most frightful nature, pulpifying the soft parts, laying open large vessels and joints, and literally crushing the bones into atoms. Under such circumstances the judicious surgeon will of course amputate at once, the very moment sufficient reaction has taken place to enable the system to bear the operation ; but instances often occur where the case has been neglected, or ill managed, and where death of the parts has already set in before we are consulted. Now it is precisely in such cases as these that the question will arise in regard to the propriety of immediate action, and much judgment and experience are frequently required to enable us to come to a correct decision. The proper procedure is not to hesitate, if the state of the system is such as to warrant the belief that it will be able to bear the shock of the operation ; but I should certainly refrain if the patient was so far exhausted as to render it probable that he would sink under it. In that event, I should endeavor to rally him by the free use of cordials, as wines, brandy, and quinine, and employ the knife only so soon as a favorable change occurred.

The question of amputation in gangrene from *embolism* is an important one, but, in the existing state of the science, undecidable. It may be stated, however, in general terms, that the operation should be performed without delay when the destructive action is rapidly advancing, provided the patient is free from serious organic disease, and is otherwise in a condition to bear the shock and loss of blood. When the reverse is the case, the proper plan is to wait for a line of demarcation ; and a similar course should be adopted when the mortification is more chronic and is evidently dependent upon the presence of a clot in the principal artery of a limb near the trunk.

2. CHRONIC MORTIFICATION.

There is a form of mortification, in many respects, the very opposite to the one just described, to which, therefore, the term chronic, or dry, may very properly be applied. It is characterized by the remarkable tardiness of its progress, by the absence of humidity, and by the deep color of the skin, which, when the loss of vitality is complete, is as black as charcoal. Mortification from embolism consequent upon ossification of the arteries, the most common cause of the disease, proceeds slowly ; mortification from ordinary embolism rapidly, death frequently doing its work in a few hours, or, at furthest, in a few days.

One of the best types of this variety of mortification is what is now generally known as senile gangrene, from the fact that it is most common in elderly subjects. It is the same disease which was so admirably portrayed, for the first time, by Percivall Pott, of London, under the appellation of mortification of the " toes and feet," and which, for this reason, is still frequently called by his name. It generally begins upon the inside of one of the small toes as a little dark, bluish, or purple speck, not larger, perhaps, than a mustard-seed, which is soon succeeded by a minute vesicle filled with a serous, ichorous, or sanguinolent fluid, and which, bursting, exposes a black surface beneath, perfectly cold and insensible. This spot gradually spreads in different directions until it involves the whole foot, as in fig. 20, as high up, in many instances, as the ankle, or even the middle

of the leg, although, in general, the patient dies long before it reaches that situation. Occasionally, the mortification begins on several toes simultaneously, or in pretty rapid succession; and I have met with examples in which it first showed itself upon the heel and instep. Dr. Charles Marr has communicated to me the particulars of a case in which the disease was confined to the lower and back part of the leg; and in an elderly female under my charge at the Philadelphia Hospital, the gangrene never extended beyond the big toe. However this may be, the part always exhibits a characteristic appearance; it is perfectly dry and withered, cold, insensible, odorless, or nearly so, and as black as charcoal, the limb looking as if it were unnaturally small, as,

Fig. 20.

Chronic Gangrene of the Feet, the Disease being Arrested, and the Parts Undergoing Separation.

in fact, it generally is. During the progress of the mortification, especially if this is somewhat rapid, the skin has occasionally a mottled, purplish aspect, owing to the coagulation of the blood in the superficial veins.

Symmetrical gangrene, as it is denominated, is closely akin to senile gangrene, and is evidently due to embolism of the capillary vessels. It is most common in women between the ages of eighteen and thirty, and originally appears in the tips of the fingers and toes, sometimes in the former, at other times in the latter. It is also liable to occur in the nose and ear. It is generally preceded by a pale and shrunken condition of the affected parts, which gradually change their color to a light blue or purple, and at length become the seat of severe pain. Sometimes the parts feel very cold and numb; vesicles filled with turbid serum usually form. The march of the disease is generally chronic; the bones rarely suffer, and the prognosis, as a rule, is favorable. When the eschars drop off, a clear, healthy sore is exposed, which gradually heals by granulations. The symmetrical development of the disease, in the two halves of the body, its liability to affect both the upper and lower extremities, the comparative youth of the patient, the severe pain, and the remarkable numbness of the affected structures, readily distinguish it from chilblain and senile gangrene. The general health is usually more or less impaired. In a case reported to me by Dr. A. M. Vedder, of Schenectady, in a lady fifty-three years of age, the tips of the index, middle, and ring fingers of the right hand had mortified as the result of embolism of the brachial artery. A similar case has been communicated to me by Dr. P. K. Graybill, of Virginia, the patient being a child, two years and a half old, the subject of a slight attack of scarlet fever, during which both legs and the lower portions of the thighs were seized with symmetrical gangrene.

Whatever its site may be, the disease is usually preceded and accompanied by pain in the toes and foot, darting about in different directions, and liable to nocturnal exacerbations, preventing sleep, and rapidly undermining the general health. The pain, which is of a burning, scalding, or stinging character, is often referred by the patient to the effects of gout or rheumatism, particularly if he was formerly subject to attacks of that nature; it steadily increases with the spread of the disease, and can only be relieved by the free use of anodynes. The dependent posture commonly aggravates it, but, in a case of gangrene of the foot, which I saw along with Dr. Mahlon M. Levis, of this city, in a man eighty-three years of age, the suffering was immensely augmented whenever the limb was elevated even for a few moments. In some instances, the attendant pain is extremely slight. Considerable swelling is occasionally present above the site of the mortification; and cases occur in which the whole of the affected extremity is very œdematous, exquisitely sore, and of a pale rose-color, or marked by an erysipelatous blush.

Although in general this form of gangrene is strictly chronic, an instance is occasionally witnessed in which it spreads with such rapidity as to entitle it to the term acute. The most remarkable case of this kind that I have ever seen, happened in a stout, fat female, sixty-four years of age, a patient of Dr. Coad, of this city, long subject to attacks of gout. The gangrene commenced in the big toe, from which, in less than a fortnight, it spread over the entire foot and lower half of the leg. The parts were as black as charcoal, shrivelled, horribly fetid, and excessively painful.

Well-marked constitutional symptoms attend this complaint, usually from the very first, and sometimes even before there is any local evidence of its presence. They are of an asthenic type either from the beginning, or they soon become so. The pulse is feeble and upwards of one hundred and twenty in the minute, quick, sharp, and irritable. The tongue is coated with a brownish fur, dry, and more or less tremulous; the appetite is impaired; the bowels are costive; the alvine evacuations are fetid; the urine is scanty and high-colored; the sleep is interrupted by pain and frightful dreams; the strength rapidly declines; and the patient gradually dies from sheer exhaustion, the period between this event and the commencement of the attack varying from six weeks to three or four months.

This form of gangrene occurs in both sexes, probably with nearly equal frequency, although it was formerly supposed to be more common in men than in women. It attacks all classes of individuals, the rich and the poor, the idle and the industrious, the temperate and the dissipated. Nearly all the cases, probably altogether a hundred, that have come under my notice, occurred among the middle and poorer orders of the community. It has been conjectured that a gouty and rheumatic temperament predisposes to its development, and cases occasionally occur which would seem to countenance such an idea. Again, it has been asserted that particular modes of life, as indolence and huge feeding, powerfully contribute to its production.

From this variety of chronic mortification few patients recover. In most instances, the disease proceeds steadily, or with an occasional temporary intermission, to a fatal termination from sheer exhaustion of the system. In a case of senile gangrene, in a man sixty-two years of age, recently under my care, the immediate cause of death was opisthotonos. Now and then, as when the powers of life are not too much undermined, the morbid action is arrested, and spontaneous amputation takes place, followed, after long suffering, by recovery. The event is denoted by the establishment of a line of demarcation, immediately above which the surface exhibits a dusky, erysipelatous blush, very different from what usually occurs in ordinary gangrene. The sloughing process is generally attended with severe pain and the most offensive odor.

The cause of senile mortification, as originally suggested by Cowper, an English anatomist, is calcification of the arteries, followed by the formation of fibrinous clots or emboli closing up the caliber of the vessels, and thus mechanically intercepting the passage of the blood. The principal obstruction, as I have ascertained by repeated dissections, occasionally exists at a considerable distance from the seat of the disease. Thus, I have found the occlusion limited altogether to the femoral artery, the popliteal, or the commencement of the tibial and fibular. In most cases, however, it affects also the smaller branches. The concretions generally exist in various degrees of development, from recent coagulation of the blood to complete organization; hence, while some may be easily detached, others are firmly adherent to the sides of the vessels.

The immediate cause of these clot formations is doubtless the interception of the fibrin of the blood by the roughened walls of the arteries consequent upon their calcification, aided by an effusion of plasma, the result of chronic inflammation of the serous membrane, thereby favoring the coagulation and adhesion of the blood.

A form of chronic gangrene of a very remarkable character is sometimes caused by the inordinate use of *ergot*, spurred rye, or secale cornutum. The affection, which has occasionally prevailed endemically, has hitherto been observed chiefly in France, Germany, and Switzerland, in certain districts of which rye bread forms a principal article of diet. When ergot enters largely into the composition of the flour, as it is apt to do in very wet seasons, and is employed for any length of time, it is liable to cause mortification in the remote parts of the body. The attention of the profession was first prominently directed to the subject in 1676, by Dodard, a French physician, and since then it has frequently been noticed by other writers. For a long time doubts were entertained respecting the power of ergot to produce this effect, doubts which were finally solved by Tessier, at the instance of the Royal Academy of Medicine of Paris. He selected for his experiments various animals, especially pigs, ducks, and turkeys, which he fed exclusively upon ergot; he found that most of them died from the tenth to the twenty-fourth day, and that distinct marks of mortification existed in the bodies of all, both externally and internally. Since the poisonous effects of this substance have become so well understood the disease has almost entirely disappeared, and in this country I am not aware that it has ever been noticed in the human subject. It is said, however, to have prevailed extensively among the horned cattle of Chester County, in this State, in 1819, and in the following year in Orange County, New York, from the free use, as was supposed, of a species of green grass, the *poa viridis*, the seeds of which were affected with ergot.

The manner in which ergot acts in producing this disastrous effect has not been explained. It is very singular that its virulence should explode upon those parts of the body which are most remote from the heart, as the feet and legs, and the corresponding portions of the upper extremities, along with the nose, chin, and ears. I am myself inclined to believe that the primary impression of the poison is made upon the blood, rendering it abnormally stimulant and plastic; and the secondary upon the inner coat of the arteries, which, becoming inflamed, thereby intercepts the liquid, and thus leads to the formation of thrombi or fibrinous clots. In a word, there can be no doubt that mechanical obstruction of the vessels is the direct and immediate cause of the gangrene, and, if this idea be correct, we cannot fail to discover the closest analogy between this form of the disease and ordinary senile mortification. It is much to be regretted that Dodard, Noel, Bossau, Gassoud, and others, who have left such admirable descriptions of the external characters of this strange affection, should not have given us any account of its pathological anatomy.

Mortification from ergotism has been observed at all periods of life; it is usually preceded by discoloration, pain, and burning heat, which, subsiding in the course of four or five days, leave the parts cold, dry, hard, insensible, of a uniform black color, and free from fetor. It generally begins in the toes, whence it gradually extends over the foot and leg, until, in some cases, it reaches as high up as the hip. Occasionally it appears simultaneously both in the lower and upper extremities, as well as in the nose and ears. Sometimes the disease is accompanied by considerable swelling and by the most excruciating pain, allowing the patient no rest day or night. The constitutional symptoms vary, being at one time very slight, at another excessive; in general, however, the patient is tormented with fever, thirst, restlessness, and high delirium. Under favorable circumstances ulcerative action is set up, and this, gradually progressing, at length eventuates in spontaneous amputation of the sphacelated structures.

Chronic gangrene is occasionally associated with, if not directly dependent upon, organic disease of the kidneys, especially that form of it which is attended with saccharine diabetes. Cases of this description have been reported by different observers, among others by Marshal de Calvi and Verneuil, who drew special attention to the subject in elaborate memoirs, published, respectively, in 1864 and 1866. The parts generally affected are the lower extremities of old persons; the malady occurring mostly in patch-like spots, and nearly always terminating fatally within a short time of the outbreak of the local trouble. The urine is sometimes both saccharine and albuminous.

Anomalous cases of chronic mortification occasionally occur, of so obscure a character as to render it impossible to refer them to any particular division of the disease, as in the extraordinary instance, recorded in the Philadelphia Medical Examiner, by Dr. Bernard Henry, of this city, the patient, a female, forty-two years of age, having gangrene of all the extremities, from the effects of which she finally died. She was the mother of nine children, was of intemperate habits, and had formerly had syphilis. The disease was preceded by stinging and burning pains in the hands and feet, which, together with the tip of the nose and the skin of the knees, gradually assumed a black, dry, and shrivelled appearance, the gangrene eventually extending beyond the middle of the arms and legs. The only lesion revealed on dissection was some contraction of the left auriculo-ventricular orifice, slightly obstructing the flow of blood into the aorta. The arteries were free from calcification and atheromatous deposits.

Treatment.—Much diversity of opinion still exists among authors respecting the proper method of treatment in chronic mortification; some favoring stimulating measures, while others are the warm and avowed advocates of depletion, as if it were possible in a disease which exhibits such a protean character to lay down any one plan that shall be applicable to all cases. Every case here as every where else, must be managed according to its own peculiar needs. Nevertheless, long experience has convinced me that the stimulant method of treatment is generally the only one that can safely be adopted. I have seen instances where, from the robust state of the individual, and the character of the pulse, no doubt could be entertained about the propriety of the employment, at least to a moderate extent, of antiphlogistic measures, where, indeed, even the lancet and antimony were admissible; but I am quite sure that the instances are comparatively rare, and that, even in them, too much caution cannot be used in their adoption. Nine patients out of ten would be injured by such a course. The symptoms are generally of a typhoid character from the very beginning of the malady, and not only so, but the disease nearly always occurs in old, worn-out subjects, or in persons who have long labored under depression of the nervous, vascular, and muscular powers, and who are therefore ill able to bear such a plan

of treatment. Tonics and stimulants, judiciously administered, and aided by appropriate local measures, constitute the proper means in such cases. Sometimes a "masterly inactivity" is more effective than anything else, the surgeon doing little more than watching the patient, and attending to his diet, bowels, and secretions. But, in general, it will be found that a supporting plan of treatment is absolutely necessary to prevent the system from falling into a hopeless state of exhaustion. Quinine, carbonate of ammonium, and tincture of chloride of iron, with wine, wine whey, or milk punch, and opium, are the most important and trustworthy articles. Anodynes are especially necessary to allay pain, induce sleep, and tranquillize the heart's action, and should be administered in full doses.

Locally, the best remedies are the dilute tincture of iodine, brushed very thoroughly twice a day over the whole of the affected surface, and the use of the bandage, applied with moderate force, and kept constantly wet with a strong solution of opium and acetate of lead, Goulard's extract, or chloride of ammonium. Leeches are usually objectionable, as their bites are sometimes provocative of gangrene, and the same remark is applicable to punctures and incisions. Wrapping the affected parts up in dry cotton is often very grateful, especially as there is generally a feeling of cold in them. By these means the inflammation in the obstructed vessels may now and then be gradually or even promptly arrested, and the further extension of the mortification prevented.

When sloughing has commenced, the same general principles of treatment are applicable as in the acute form of the disease, only that the local applications should, if possible, be still more mild and soothing. The most eligible remedies, according to my experience, are the nitric acid lotion, in the proportion of two to six drops of the acid to the ounce of mucilage of gum arabic, or the opiate cerate, for the ulcerated surface, and cloths constantly wet with a solution of chlorinated sodium for the dead, especially if there be much fetor. As the parts become detached they may be removed with the scissors, but this must be done with the greatest gentleness, as the slightest injury inflicted upon the living tissues is sure to be productive of mischief.

In regard to the question of *amputation*, it is extremely difficult to offer any satisfactory opinion. My belief, founded upon considerable experience, is that we ought scrupulously to follow the practice long ago laid down by surgeons, not to interfere until there is a well-marked line of demarcation; and, indeed, not even then, unless it is evident that there is sufficient strength of the system to bear the shock of the operation. I have, however, seen several cases where amputation was succeeded by the most happy results before nature had made any attempt to cast off the slough, and that, too, under circumstances apparently not at all promising as it respected the powers of the constitution. Whenever surgical interference is deemed advisable, no means should be spared to support the patient with tonics and stimulants, as upon their judicious use the chances of his recovery will, in great degree, depend. When the operation is performed prematurely, or before the system has sufficiently recovered from the exhausted condition consequent upon the gangrenous action, the disease will generally reappear within a few days upon the stump, or death will follow from sheer exhaustion.

At what point should the limb be removed in this form of mortification? Should it be cut off, as is so generally done, close to the line of demarcation? Such a proceeding would only lead to a speedy recurrence of the disease. Instead of this, a remote point should be selected, one, if possible, some distance above the seat of the greatest degeneration of the principal artery of the limb. Thus, it seems to me, as I have long taught, that, when the gangrene is limited to the toes and lower part of the foot, amputation should be performed high up in the leg, and when it affects the upper part of the foot, or foot and ankle, at the inferior third of the thigh. The only objection to such a proceeding would be the greater risk from the operation on account of its closer proximity to the trunk; but this would be more than counterbalanced by the greater safety on account of its distance from the seat of the disease. Some of the cases treated upon this principle by different surgeons within the last ten years have done well; but the number is not sufficiently large to justify us in deducing from them any rule of practice.

The treatment of chronic mortification from ergotism is involved in mystery. There is no remedy, so far as is at present known, the employment of which exerts the slightest counteracting influence upon the deleterious effects of this substance upon the system. Hence the only proper plan of procedure is to manage all such cases upon the general principles just laid down in respect to the treatment of the ordinary forms of the disease. In the symmetrical variety of gangrene, our chief reliance must be upon iron and quinine, with opium and good diet, and the application of slightly stimulating lotions and cataplasms.

SECT. VIII.—HOSPITAL GANGRENE.

Under this name may be described a variety of mortification, or of mortification and ulceration, which often commits great ravages among the wounded in crowded hospitals, in camps, and on board of vessels of war. The disease appears to be much more common in Europe and in the East than in this country, where it is exceedingly infrequent, even in our larger eleemosynary institutions, while in private practice it is almost unheard of. During the late war, however, it was sufficiently prevalent among our wounded soldiers. I place this affection between mortification and ulceration, as it evidently, in many cases, if not in all, strongly partakes of the nature of both.

Although it is extremely probable that hospital gangrene has existed from time immemorial, no distinct and satisfactory account of it appeared until 1783, when an admirable description of it was published in the posthumous works of Pouteau, of Lyons, who had himself suffered from a severe attack of it while resident pupil of the Hôtel-Dieu of that city. Soon afterwards attention was directed to it by Dussassoy, whose treatise was rapidly followed by the tracts of Moreau, Burdin, Gillespie, Leslie, Blackadder, Brauer, and Boggie, to whose joint labors we are mainly indebted for our present knowledge of the affection.

Various names, all more or less expressive of the nature of this disease, have been employed to designate it by different authors. Thus, by Pouteau and some of the earlier writers upon the subject, it was denominated hospital gangrene, evidently in reference to the frequency of its occurrence in this class of public institutions, of which it was at one time the great scourge, both in military and civil practice, particularly the former. Subsequently it was described under the appellations of contagious gangrene, gangrenous phagedena, putrid degeneration, malignant sloughing, or putrid ulcer, camp gangrene, and humid hospital gangrene.

Sporadic cases of this variety of gangrene, more or less severe, are occasionally met with in all large hospitals and other places crowded with sick and wounded, but we no longer hear of that frightful devastation which used to characterize its existence in former times. This happy change is no doubt due to the great attention which the modern practitioner bestows upon ventilation and cleanliness, and the prompt segregation of his patients on the appearance of the malady. According to Mr. Macleod, hospital gangrene was not at all common among the English during the war in the Crimea; it prevailed during the first winter in a mild form at Scutari, but it never became either general or severe, although the barrack hospital of that city was, during the early occupation of the troops, in a very filthy and uncomfortable condition. Whenever any cases broke out, the patients were at once isolated, and sent into wards specially set apart for the treatment of the disease. The French, on the other hand, suffered most severely, owing, as was supposed, to the injury which they sustained during their removal immediately after being wounded to the hospitals on the Bosphorus, and to the manner in which they were crowded together in the wards of those institutions.

Formerly hospital gangrene often prevailed as an endemic, attacking almost every one that was brought within its baneful influence, and thus causing the most horrible mortality. In the Hôtel-Dieu, at Lyons, in the time of Pouteau, several frightful outbreaks of this sort appeared, and such were their ravages that this distinguished surgeon was induced to ask the question, whether hospitals were not an evil instead of a blessing. In 1780, the disease prevailed extensively among the inmates of the naval hospital at New York, some of whom had been sent thither from the West Indies, others from the American squadron, then in port on account of stress of weather. Upwards of two hundred cases occurred, and of these many died; quite a number from the recurrence of gangrene upon the stump after they had suffered amputation. In 1781, the malady committed terrible ravages at the naval hospital on Pigeon Island, St. Lucia. In 1800, it prevailed extensively on board the Prince of Wales, on her homeward passage from Martinique to England; the suffering was excessive, and every little scratch or injury, in whatever manner inflicted, speedily degenerated into a bad gangrenous ulcer. A short time before this, the disease existed in a very severe form at the Cape of Good Hope. Of the horrible ravages, which it occasionally commits at sea, an idea may be formed when it is stated that sixty bodies were thrown overboard by one vessel in thirty-eight hours in her passage from the Bosphorus to the south of France. At Bilbao, after the battle of Vittoria, the mortality from this source was excessive. In the Parisian hospitals, the disease has prevailed, off and on, for many years, often sadly interfering with the results of surgical accidents and operations. In 1847, it appeared in some of the London hospitals, and nearly at the same time in some of those at Edinburgh; in both cities, however, in a mild and transient

manner. In the Philadelphia Hospital I saw cases of the disease, in a more or less severe form, every winter during my connection with that institution, chiefly in old worn-out persons, the subjects of chronic ulcers of the extremities, accompanied with a scorbutic state of the system, brought on apparently by an insufficient supply of vegetables and subacid fruits.

During the late war the disease prevailed more or less extensively in many of our military hospitals. It was particularly troublesome, for a time, at Annapolis, Washington, Baltimore, New York, Louisville, and Frederick, Maryland, after the engagements at South Mountain and Antietam, in September, 1862. At the latter place, it manifested, as has been asserted by Dr. Alfred North, a very decided preference for ulcers of the lower extremities in an advanced state of cicatrization ; with a single exception, no recent wounds were attacked, although numerous operations were performed. In the military hospitals in and around this city comparatively few persons suffered from it, and of these most recovered.

These references are interesting, as showing the occasional epidemic tendency of this disease, and the consequent absolute importance of avoiding the huddling and crowding together indiscriminately of the sick and wounded in large hospitals, camps, and other places, often selected with little judgment, for the accommodation of the poor. There can be no doubt whatever that much, if not the whole, of the immunity enjoyed by the hospitals, infirmaries, and almshouses of this country, is due to the vigilance that is exercised in the sequestration of their inmates, and the great attention that is paid to the cleanliness and ventilation of these establishments ; circumstances which never fail to exert a powerful prophylactic influence upon this and other diseases whose origin and propagation are so closely connected with a vitiated state of the atmosphere and a disordered condition of the blood.

Hospital grangrene shows itself in one of two ways, either as an original affection upon an unbroken surface, or in connection with an abrasion, open wound, ulcer, or amputated stump ; more frequently in the latter than in the former. When the tendency to the disease is very strong, the slightest scratch, sore, or wound may become the means of propagating it, and of producing the most frightful ravages. Several instances have been recorded of the most horrible sloughing occasioned by the accidental inoculation of the bite of the mosquito. When the disease prevails endemically, or even when there is merely such a tendency, no operation, however insignificant, can be performed with any certainty that it may not be followed by hospital gangrene. The stripes inflicted in flogging soldiers have frequently been known to become the seat of the disease in its very worst form. Boils, abscesses, sinuses, fistules, and cicatrices generally, under such circumstances, share a similar fate. It has been noticed that, when hospital gangrene exists as an endemic, it manifests but little disposition to seize upon ulcers of a specific nature, as chancres, venereal buboes, and malignant sores. In its sporadic form, on the contrary, these are the parts which seem to be particularly liable to suffer, the disease often attacking them, apparently, in preference to simple ulcers.

The distinction which has been made by some authorities, of this disease into sloughing and phagedenic, seems to me to be improper, since it is evident that the two affections are merely different grades of the same disorder, the one destroying the tissues in large masses, the other on a small scale, the action by which this is done being strictly identical in both cases. A much more important division is that into idiopathic and traumatic, the origin of the former depending upon constitutional causes, that of the latter upon external injury. In many cases the disease is strictly chronic ; at all events, a disposition to its occurrence sometimes manifests itself for weeks and even months together.

With respect to the *causes* of this variety of gangrene, while some regard it as a strictly local affection, others consider it as having a constitutional origin ; and in this opinion I am strongly inclined to concur, from a careful study of the history of the disease, both from what I have seen of it myself, and from the accounts given of it by different writers. Possessing many features in common with erysipelas and septicemia, it is highly probable that, like these diseases, it owes its origin to a species of blood-poisoning, depending upon a foul, infected atmosphere, operating upon a depraved and enfeebled constitution. It is very certain that the strong and robust are much less liable to suffer from it than those of an opposite state of the system, or who have become exhausted by intemperance, disease, exposure, or want of proper food ; and it is often easy to determine, beforehand, when a great many persons are crowded together in the wards of an infected hospital, which will be likely to be attacked and which to escape, simply from the differences in their appearances. Whether the subjects of hospital gangrene are capable of generating

a poison which, in its turn, can impart the disease to others, by its operation upon the system, is still a mooted point, although an extremely probable one. However this may be, the fact that the malady may be communicated by actual contact of the secretions of a gangrenous sore with a sore of a healthy character, is well established. A very striking circumstance, bearing strongly upon the question of the existence of a distinct poison elaborated during the progress of this malady, has been recorded by Sir George Ballingall, in his Outlines of Military Surgery. Speaking of the disease as it prevailed in a regimental hospital at Feversham, in 1806, he states that, after the endemic had been going on for some time, it was discovered that all the ulcers in the establishment had been washed with one sponge. A different mode of cleansing the sores was immediately adopted, and not a single case of gangrene appeared afterwards. When to this circumstance is added the result of the experiment of Ollivier, who produced the disease in his own person, by inserting matter, taken from an ulcer of the very worst description, into the arm just below the attachment of the deltoid muscle, it is impossible to withhold our belief in the contagious property of traumatic hospital gangrene. The case of Blackadder, who suffered severely from a puncture accidentally inflicted upon one of his fingers in dissecting the stump of a man dead of this affection, is equally strong and convincing.

A scorbutic state of the system, severe shock, loss of blood, and, in short, all depressing influences whatever, probably act as so many predisposing causes of this disease, by lowering the powers of the heart and nervous system, and thereby favoring the operation of the septic poison. Protracted courses of mercury, or exposure to wet and cold during salivation, have often been followed by the disease during its endemic prevalence. In private as well as in hospital practice, it is particularly liable to be induced in young, unhealthy, scrofulous persons, affected with syphilitic ulcers, and weakened by all kinds of privation, especially the effects of cold, and the excessive use of ardent spirits. In the army and naval service of Europe, it formerly often supervened upon severe and exhausting attacks of dysentery, scurvy, and typhoid fever.

When many persons are crowded together, the air of the apartment soon becomes contaminated by the elimination of carbonic acid gas from the lungs, and by the various emanations from the body, the urine, and the feces, so as to render the atmosphere entirely unfit for the purposes of respiration. The deleterious impression is much increased if the patients are laboring under extensive wounds or ulcers, the exhalations from which are often, of themselves, sufficient to poison the system of the stoutest individual.

The period of latency of the poison of hospital gangrene is undetermined. It probably varies in different persons and in different cases, depending upon the previous state of the general health, and the peculiar mode of the infection. In most cases it is short, not exceeding thirty-six or forty-eight hours before it shows its specific effect. When the infection is indirect, a longer time is probably required for the development of the disease than when it is direct, or effected by actual contact of the secretions.

The disease occurs at all periods of life in both sexes, and at all seasons of the year, although it is most common, as well as most virulent, in hot weather.

The *symptoms* are partly of a local, partly of a constitutional nature, the order of their priority being not always easily determined. When it supervenes upon a wound, an ulcer, or the stump of an amputated limb, the appearance of the preëxisting affection undergoes at once a series of the most important changes, completely modifying its whole aspect. The discharge is sensibly diminished, or, perhaps, entirely dried up ; the granulations, if any exist, assume a dark, foul appearance, and are rapidly destroyed ; a large quantity of aplastic lymph, of a dirty grayish color, soon covers the bottom of the sore, the edges of which at the same time become jagged and everted ; the adjacent parts are of a deep purple or livid hue, and the seat of numerous vesicles, filled with sanious or bloody serum ; the pain is constant and excessive, being sharp, biting, or stinging ; the affected structures exhale a horrible odor ; and swelling is both great and threatening. Sloughing now takes place, skin, connective tissue, fascia, and muscle often dropping off in large, livid, putrescent masses, thoroughly impregnated with the most horribly offensive secretions. In the more severe forms of the lesion, the ravages are not limited to the soft parts, but extend to the bones and even to the joints ; the affection, perhaps, rapidly travelling up a limb until it is completely destroyed. Long before this crisis has been attained, indeed generally at an early period, glandular swellings are observed in the groin or axilla, possessing many of the features of pestilential buboes : they usually involve a number of glands, and are always exquisitely tender and painful, thus greatly aggravating the local and constitutional distress. When suppuration occurs, which, how-

ever, is not invariably the case, the discharge is generally abundant and highly fetid, and the resulting ulcer speedily exhibits all the characteristics of the parent sore.

When the disease appears on an unbroken surface, its advent is announced by the formation of little vesicles, or blebs, filled with ichorous fluid, and surrounded by a reddish areola ; both gradually extending, the former soon burst, and thus reveal a dirty, foul slough, which, dropping off, exposes a filthy-looking, excavated cavity, incrusted with a thick layer of adherent, grayish, unorganizable lymph. The parts feel hot and stinging, and there is great swelling, with livid discoloration of the adjacent surface, and a tendency to rapid extension and destruction, the different tissues dying either together or successively, in the same manner as when the disease is ingrafted upon an ulcer or open sore.

As it respects the appearances of the affected structures, hospital gangrene presents three tolerably distinct varieties of form. In one the parts perish, as it were, in mass, and are of a dark red color, very moist, fetid, and infiltrated with putrescent, sanious matter. In a second class of cases, the tissues are converted into a pulpy, diffluent putrilage, or into a dark, brownish, dirty-looking substance, of the consistence of starch, pap, soft cheese, or currant jelly. Finally, there are cases, and these are by no means uncommon, in which, the action being purely ulcerative, the death is molecular, the affected structure melting away, as it were, in an almost imperceptible manner.

The constitutional symptoms are generally well marked, their severity being usually in proportion to the violence of the local disturbance. If the patient, prior to the attack, was tolerably strong and robust, they will probably be of a strictly inflammatory nature, but in any event they will soon lose this type, and assume the asthenic form, which will become more and more distinct as the disease pursues its downward tendency. The pulse will be found to be unusually frequent, quick, and irritable ; the mind peevish, fretful, and desponding ; the tongue dry, and covered with a brownish fur ; the strength much impaired ; and the pain so excessive as to deprive the patient completely both of appetite and sleep. Delirium often sets in at an early period, forming one of the most prominent symptoms.

The *diagnosis* of hospital gangrene is generally not difficult, for there are but few diseases with which it can be confounded. Almost the only affection, indeed, for which it is in danger of being mistaken is scurvy, but a little attention will usually serve to render the distinction between them very evident. The scorbutic ulcer, as it has been named by Lynd and other writers, is remarkable for its fungous, livid, bloody, and fetid character, and the granulations are of enormous size, very soft and spongy, growing with great rapidity, and bleeding copiously upon the slightest touch. The discharge is profuse, and the blood often lies in cakes upon the surface of the sore, from which it is wiped with difficulty ; the pain is trivial, and the granulations, if cut away, are speedily reproduced, generally in the course of a single night. Ulcers of this kind are nearly always attended by serious disease of the gums, which are fungous and extremely vascular, and by hemorrhagic spots in different regions of the body. There is, also, as another striking diagnostic circumstance, an absence of fever, and, generally, also, of vesication. In hospital gangrene, on the contrary, there is always grave constitutional disorder, while the local phenomena are denotive of high vascular action. The ulcer is foul, exquisitely painful, deeply incrusted with lymph, and surrounded by a livid, vesicated surface. The granulating process is speedily arrested, and the sloughing extends in every direction.

The *prognosis* varies with many circumstances. Thus, it is always, other things being equal, more unfavorable when the attack is of an epidemic character than when it is sporadic, and in persons who have been exhausted by previous suffering, privation, or intemperance, than in the young and robust. The extent of the disease must also necessarily exert a material influence upon the progress of the case, the danger being less when this is slight than when it is considerable, and conversely. Serious involvement of the brain, the early occurrence of delirium, or the development of secondary disease in some internal organ, as the lung or liver, always portends evil, and should induce a guarded prognosis. Formerly, hospital gangrene was an extremely fatal disease, the mortality being often in the proportion of one to three of those attacked. In some instances, indeed, nearly one-half perished. Since the pathology of the disorder, however, has come to be better understood, comparatively few cases prevail.

Death may be caused by mere exhaustion of the vital powers from the extreme violence of the morbid action, or from the occurrence of repeated hemorrhages, as when an important vessel is laid open during the sloughing process. In general, the arteries and veins are among the last structures that yield to the devastating influence of the disease, and it, therefore, seldom happens that they are not protected by a provisional clot ; occasionally,

however, nature fails in her efforts, and the bleeding may then not only be profuse but fatal. Finally, there is a class of cases, by no means uncommon, in which, although the suffering is very great, death is apparently caused by an empoisoned state of the system, induced by purulent infection, or the formation of secondary abscesses. The time at which death occurs varies from a few days to several weeks from the commencement of the attack.

Treatment.—The treatment of hospital gangrene was, until lately, very little understood, and the consequence was that an immense number of persons were lost by it. The indiscriminate use of bark and other stimulants, so much in vogue among the army and naval surgeons of Europe, especially those of Great Britain, even down to the time of the late Mr. Hennen and his colleagues in the Peninsular wars, exercised a most destructive influence upon the subjects of this disease. No judgment seems to have been employed by these practitioners, in adapting their remedies to the exigencies of their cases; all were treated alike, and the result was an amount of mortality that was often truly appalling. Dr. Boggie did much to reform this vicious system, by substituting the use of the lancet; but it is questionable whether he did not err by carrying his measures to the opposite extreme. However this may be, it is certain that neither plan is applicable to all cases; but that the management of each must depend upon its own contingencies. The abstraction of blood can, as a general rule, be required only in persons of a comparatively robust constitution, and in the earlier stages of the disease; but even then it should be practised with much caution, lest it lead to fatal exhaustion, or so far damage the system as to prevent it from shaking off, without great difficulty, the morbific influence. The disease, it must be recollected, has an asthenic tendency, often from the very start, especially when it is of an endemic character; and, therefore, any measures calculated to favor this tendency must necessarily exercise a pernicious influence.

Purging and attention to the diet and the secretions constitute important elements in the treatment, and must on no account be neglected. A good dose of calomel and rhubarb, or of equal parts of blue mass, jalap, and compound extract of colocynth, given at the outset of the disease so as to induce two or three large, consistent, alvine evacuations, will often be more beneficial in arresting the morbid action than almost everything else. Subsequently the bowels should be maintained in a soluble condition, without establishing any decided drain upon them, and the utmost care should be taken to restore the secretions, which are always so much disordered in hospital gangrene. Mercury, as a salivant, is to be avoided as a poison.

When the system begins to flag, whether from the overwhelming influence of the attack, or from the neglect of proper treatment, prompt recourse must be had to quinine, iron, wine, brandy, beef-essence, and nutritious broths. The best preparation of iron is the tincture of the chloride, given in doses of fifteen to twenty-five drops, every three or four hours, in some mucilaginous fluid. Quinine is extremely serviceable, and there are few cases, when this stage has been attained, which will not be immensely benefited by brandy, or some other form of alcohol, especially if combined with milk.

But the great constitutional remedy in hospital gangrene is opium, either in substance, or in the form of morphia. It should be given in large doses, generally not less than from two to four grains, every six or eight hours, in union with a diaphoretic, as ipecacuanha, or the neutral mixture. When we reflect upon the excessive pain, irritability, and sleeplessness which so generally attend the severer grades of this disease, it is impossible to place too high an estimate upon the value of anodynes as means not only of insuring comfort to the patient, but of arresting the morbid action.

The diet, especially in the more advanced stages of the disease, should be highly nutritious, and as concentrated as possible. The patient's room should be constantly ventilated, the bed and body clothes daily changed, and the cutaneous surface frequently sponged with tepid salt water, or weak alkaline solutions. The chlorides, bromine, or permanganate of potassium should be freely used. When the disease manifests an endemic tendency, as when it breaks out on board ship, or in the crowded wards of a hospital, the sick should be promptly sequestered, and the apartments thoroughly cleansed.

When the disease is obviously connected with a scorbutic state of the system, the best internal remedies are potassa, in union with lemon-juice, potatoes, water-cresses, oranges, onions, tomatoes, and other fresh fruits and vegetables.

The local treatment should be as gentle and soothing as possible; not rough, irritating, or perturbating. Any vesicles that may exist should be promptly opened either with a needle or with the point of a bistoury, and the whole of the affected surface pencilled over with dilute tincture of iodine, followed by a strong solution of acetate of lead and opium,

either cold or tepid, a cloth wet with it being constantly kept upon the part. If mortification has taken place, the dead substance should be removed without delay, and the exposed surface, thoroughly cleansed and dried, should be freely mopped with a weak solution of acid nitrate of mercury, carbolic acid, nitric acid, sulphate of copper, or perchloride of iron, with a view of changing capillary action and allaying fetor. All strong applications should, in my opinion, be avoided, as they are not only extremely painful, but generally productive of mischief by their tendency to depress the vital powers. If the disease manifests a disposition to spread, and there is, at the same time, excessive suffering, with a marked feeling of tension, scarifications and incisions must be practised, in the same manner and with the same object as in erysipelas.

Attention to cleanliness is of paramount importance. The best mode of effecting this is to cut away carefully all dead substance as fast as it forms with the knife or scissors, to wash the raw surface thoroughly with a weak solution of chloride of zinc, permanganate of potassium, or chlorinated sodium, and, finally, to soak up with cotton or lint every particle of moisture. Unless this be done, no application will be likely to be of any material service in arresting the morbid action.

During the late war extensive use was made, chiefly on the recommendation of Dr. Goldsmith, of pure bromine in the treatment of this affection. It was generally applied by means of a glass test-tube to the whole of the raw surface, previously divested of slough, and thoroughly dried. The parts were then covered with a yeast, cinchona, or port-wine poultice. One application usually sufficed; if a second was necessary, it was not made under several days.

Dr. Hinkle found a favorite remedy in permanganate of potassium well known for its powerful deodorizing, disinfecting, and oxygenating properties. He used it both internally and externally; internally, in doses of one or two grains several times in the twenty-four hours, and externally, as an escharotic, in concentrated solution, applied by means of a camel-hair pencil to the surface of the wound and also to the cuticle for some distance around. The parts were first thoroughly cleansed with Castile soap and water, and afterwards covered with lint soaked in a weak solution of the medicine, the dressing being renewed every three hours. When the wound was deep seated or inaccessible, medication was effected with the syringe. The sloughs usually separated in from four to six days, leaving a healthy sore which soon healed under simple treatment.

Dr. John S. Packard derived great benefit from the employment of powdered white sugar, thickly dusted upon the raw surface, which was then covered with wet lint, confined by adhesive strips and a bandage. The application, which was always preceded by the thorough removal of slough and matter, was found to be extremely useful in checking the morbid action, and was relied upon almost exclusively in the treatment of this affection in several of the military hospitals in and around this city. Buttermilk yielded excellent results, in one of these institutions, in the hands of Dr. Walter F. Atlee; and Professor L. A. Dugas, of Georgia, found nothing so beneficial as tar-water. The application of lactic acid, as suggested by the late Professor Samuel Jackson, of this city, on pledgets saturated with the fluid, and frequently renewed, is worthy of trial. Subsulphate of iron—Monsel's salt—is also an excellent remedy, at once mild and efficient, promptly neutralizing fetor, and rapidly changing the action of the sore. It is a powerful deodorizer and desiccant.

The hot iron, formerly so much vaunted as a remedy in the treatment of this affection by the French and German surgeons, will not be likely to have many advocates at the present day. That the application, especially if it embraces the whole of the diseased surface, may occasionally be beneficial, is unquestionable; but there are so many more efficient and agreeable measures that it may well be abandoned.

Personal experience fully satisfies me that, if care be taken to cleanse the wound properly of slough and sanious matter, which is always poured out in such great abundance in this affection, it is of little consequence whether the application be carbolic acid, acid nitrate of mercury, nitric acid, sulphate of copper, creasote, tar-water, bromine, nitrate of silver, permanganate of potassium, sugar, or buttermilk. A port-wine poultice, or a poultice made of elm bark or flaxseed meal, sprinkled with quinine or cinchona, often answers an excellent purpose, and there are few, if any, articles more likely to prove serviceable than pyroligneous acid. The remedy, however, which I have found most useful is acid nitrate of mercury, freely diluted with water, and carefully applied with a soft mop.

When the mortification is arrested, amputation must not be thought of until there is a decided line of demarcation, with sufficient power in the constitution to bear the shock of the operation. The tendency to recurrence of the gangrene, after removal of a limb,

is sometimes astonishingly great. Salleron, of Lyons, during his attendance upon the hospitals at Constantinople, during the Crimean war, witnessed cases in which the disease relapsed four, five, and even six times, owing apparently to the foul atmosphere of those institutions. As soon as the men were able to bear the voyage, they were sent to France. During convalescence, change of air always proves an important auxiliary to recovery.

SECT. IX.—ULCERATION AND ULCERS.

Ulceration is the molecular death of a part, as mortification is the destruction of a part upon a large scale: in a word, it is death in miniature. At least three distinct acts are concerned in its production: softening, disintegration, and, lastly, removal of the affected tissues as effete and extraneous matter. Antecedently, however, to these acts there is another paving the way for their advent, namely, inflammation, which is always an indispensable accompaniment of the process, whatever its site, stage, or degree. It was formerly supposed, chiefly in conseqence of the influence of the writings of John Hunter, that ulceration consisted essentially in the disintegration and absorption of the suffering textures; hence the general use of the phrase "ulcerative absorption." According to this doctrine, the diseased substance, after having been devitalized, is taken up by the absorbent vessels, and thrown into the blood, to go the rounds of the circulation, and be finally cast off as excrementitious matter. There are numerous circumstances which, at first sight, would seem to favor such a view. Thus, large ulcers sometimes form in a very short time, and yet it is quite impossible, so far as can be ascertained by the most careful scrutiny, to determine what has become of the tissues concerned in their development. If search be made for them in the discharges, they cannot be discovered, since their quantity, however great, is frequently insufficient to account for the loss of solid material. Similar phenomena are witnessed in abscesses of the brain, lung, liver, and spleen, where enormous destruction of the proper substance of these organs often occurs from the accumulating pus, without our being able to explain what has become of it. It might naturally be supposed that the lost tissues were contained, in an altered and disintegrated condition, in the pus, but such a conclusion is disproved by the fact that it is impossible to detect their presence by the most careful examination.

The disease appears under two varieties of form, the open and occult or, as it may not inaptly be termed, the subcutaneous. The first is by far the more common. Of the latter, examples are seen in various kinds of abscesses, sinuses, fistules, Pott's disease of the spine, coxalgia, and other affections, in which the morbid action is carried on beneath the skin, out of sight, instead of upon an open surface.

Ulceration has a remarkable disposition to invade some structures and to shun others. Those which are most liable to its inroads are the dermoid and mucous tissues, the cartilages, bones, lymphatic glands, tonsils, uterus, lungs, and kidneys. The fibrous and serous membranes, muscles, tendons, vessels, nerves, brain, heart, liver, and spleen, together with the salivary, prostate, and thyroid glands, seldom suffer from it. Newly formed parts, as cicatrices and the callus of broken bones, are easily affected by ulceration, especially when, from any cause, there is a depraved and impoverished condition of the system. It is worthy of remark, both in a pathological and practical sense, that this action is much more prone to occur in certain portions of the same structure than in others. Thus, ordinary ulceration of the skin is by far most frequent in the legs and feet, whether because these parts are in a state of habitual congestion, or because they are more exposed to fatigue and accident, is not determined. The disease is extremely rare in the œsophagus, but very common in the pharynx, tonsils, tongue, cheeks, and lips. The same remark is true of ulceration of the stomach and small intestine as compared with ulceration of the colon and rectum. In the genito-urinary division of the mucous system a similar law obtains. Thus, the affection is extremely rare in the urethra and bladder of the female, but very common in the vulva, vagina, and uterus. The male, on the contrary, seldom suffers from ulceration in any portion of the genito-urinary apparatus, except as a result of venereal diseases.

Ulceration is common or specific; common, when it is the result of ordinary inflammation, specific when it is caused by a special poison, as, for example, that of syphilis. In the latter case, the disease runs a peculiar course, and, during its progress, furnishes a specific secretion, capable, by inoculation, of producing a similar action. The ulceration that attends carcinoma is also specific, but the matter yielded is not communicable by actual contact

Ulceration varies in its progress, being sometimes very rapid, at other times very tardy. The circumstances which determine this result are not always appreciable, but, in general, they depend upon the nature of the exciting cause, the amount of the attending inflammation, and, above all, the state of the system. When the action is very rapid, an extent of surface may be destroyed in a few days which cannot, perhaps, be repaired under several months. The process often goes on simultaneously at several points in the same organ or tissue, and not unfrequently in structures of an entirely opposite character.

The causes of ulceration do not differ from those of inflammation, more or less of which, as previously stated, always accompanies the process. They may very properly be divided into predisposing and exciting. The former comprise an impoverished state of the blood, however induced, and, in short, whatever has a tendency to impair the powers of the system. Experiments, performed long ago, by Magendie and others, have established the fact that the protracted and exclusive use of starch, sugar, and other non-azotized articles of food, is capable of producing ulceration of the cornea; and it is well known that the poorer and more ill-fed classes of people are peculiarly subject to ulceration of the skin and mucous membranes. Ulceration of a severe nature often follows upon scurvy and the various kinds of fever, especially typhoid, scarlet, and morbillous, from the exhausting influence which they exert upon the solids and fluids.

The exciting causes may be common or specific, the latter being such as act primarily upon a particular part, as, for example, the head of the penis in chancre, or, secondarily, in the same disease, upon the constitution, in consequence of the absorption of the specific poison. Tubercular, scirrhous, encephaloid, melanotic, and sarcomatous tissue, after having undergone softening, always creates ulceration by its pressure upon the adjacent soft textures, thereby favoring its elimination from the part and system.

The inflammation which precedes and accompanies ulceration varies much in degree, as well as in character. When acute, it is usually marked by the phenomena which ordinarily distinguish it under other circumstances, as discoloration, heat, swelling, pain, and disordered function, and then often spreads with great rapidity, laying waste a large amount of tissue in an almost incredibly short time. When this is the case, the molecular structures perish, as it were, in mass, and not in the slow and gradual manner which characterizes the disease when the inflammation is of a more mild and simple grade. It is to this form of ulceration that the term phagedenic is commonly applied, from a Greek compound literally signifying to eat, feed upon, or erode, the parts around the breach made by the morbid action being rapidly disintegrated, melted down, and cast off, as if they had been consumed by fire, their ashes alone being left as the evidence of their former existence. When the concomitant inflammation is chronic, the ulceration generally advances more tardily, and is also marked by milder symptoms; this rule, however, has many exceptions.

The pain of ulceration is sometimes peculiar, affording thus valuable diagnostic information. Thus, in ulceration of the joints and bones, it is usually heavy, aching, or gnawing; in rupia, hot and burning; in scirrhus, sharp and lancinating, or like the pricking of a needle. Sometimes, again, there is a complete absence of pain, as in common ulceration of the skin, in ulceration of the glands of Peyer in typhoid fever, and in ulceration in tubercular disease of the large bowel. The pain, as a rule, is more severe in the acute than in the chronic form of the disease, and it is then also more steady and persistent. In syphilitic ulceration of the skin and bones, the suffering is often intermittent, the paroxysm usually coming on at night, and gradually disappearing towards morning. Finally, the pain may be of a neuralgic nature, although this is rare.

Ulceration is always attended with more or less discharge of matter, the quality of which is greatly influenced by the nature of the case. Thus, when the attendant inflammation is unusually high, the matter is generally sanious, bloody, ichorous, corrosive, and profuse; a similar fluid is always present in ulceration of carcinomatous growths. When the action is less severe, or tending to restoration, the discharge is commonly somewhat consistent and of a yellowish color, like laudable pus.

The tendency in ulceration is usually towards the nearest surface, an occurrence which is often of great service in the evacuation of abscesses and the discharge of foreign matter. It would seem as if nature availed herself of the operation of this law to economize time, save structure, and prevent pain. If it were otherwise, abscesses would often, if indeed not generally, be emptied in the most tedious and circuitous manner, and at the expense of vast suffering, both local and constitutional. Of the beneficial effects of this law, an illustration is afforded in collections of pus in the liver, which, as a rule, discharge themselves, not through the walls of the abdomen, which are thick, muscular, and resistant,

but through a contiguous coil of intestine, which is thin, proximal, and yielding. In abscess of the lung, the matter usually escapes through a neighboring bronchial tube; when it makes an effort to empty itself externally, it either pours the fluid into the pleural cavity, thus speedily causing fatal inflammation, or it attains its object only after a long and tedious process of ulceration, generally accompanied with great pain and hectic irritation.

When ulceration has continued for some time, it manifests a disposition either to remain stationary, to cease altogether, or to progress in a modified form. Its conduct, in these various particulars, is greatly influenced by internal and external circumstances, as the state of the constitution, the amount of the local inflammation, the nature of the exciting cause, and the effects of remedies. In the skin of the lower extremities, in syphilitic rupia, in the spongy structure of the bones, in the movable joints, and in malignant growths, it often continues for an almost indefinite period, being better at one time and worse at another. When it is about to cease, the accompanying inflammation gradually subsides, the discharges disappear, and, plastic matter being poured out, granulations are formed, by which the breach is finally closed, the process of cicatrization generally, if not always, proceeding from the circumference toward the centre.

In the treatment of ulceration, the great and leading indication is to combat the concomitant inflammation, so as to place the part in a condition for the efficient development of granulations, as it is through their agency that the lost substance must finally be repaired. For this purpose the ordinary antiphlogistic appliances are to be put in requisition and continued until the morbid action has been completely arrested, as will be denoted by the subsidence of the pain, heat, swelling, and redness by which it is usually characterized. When granulations begin to form, only the most mild and soothing measures must be employed, and the sore carefully watched to keep it in a healthy condition until it is perfectly cicatrized. In specific disease, as chancroid and malignant pustule, the most efficient treatment, provided the case is seen in time, before the matter has gained entrance into the veins and lymphatics, is to cut out the part, or destroy it with the actual cautery, Vienna paste, or acid nitrate of mercury.

In ulceration under the skin, or skin and mucous membrane, such as is witnessed in sinuses, fistules, and other diseases, a cure can seldom be effected without the free division of the affected structures; injections, simple and medicated, and systematic compression, however long continued, generally fail; the knife is the most effectual remedy, and its early employment often prevents an immense amount of suffering. General treatment is, of course, not neglected. In most cases tonics and other supportants are required to invigorate the exhausted constitution.

ULCERS.

An ulcer is a breach in continuity of a surface, organ, or tissue, attended with inflammation, and a discharge of pus, ichor, or sanies. The disease, which is of frequent occurrence, is met with at all periods of life, in both sexes, and in all classes of persons, and is often a source of great suffering to the patient, as well of immense trouble and vexation to the surgeon. Its very name carries with it an idea of loathsomeness, and it may well be imagined how much this feeling is increased when, as so often happens, the sore is the seat of foul and offensive discharges, rendering the patient disagreeable alike to himself and to all around him.

There is not, it may confidently be asserted, in the whole domain of surgery, a class of maladies, the pathology and treatment of which are so little understood by the profession generally as those of ulcers. It is surprising what an immense amount of confusion still exists upon the subject even among many of the best and most experienced authors. In examining the various treatises on surgery, in the principal languages of Europe, the reader has little cause to congratulate himself upon the progress that has been effected in this department of the healing art. He looks almost in vain for any positive additions to his stock of knowledge since the latter part of the last century, when Mr. Benjamin Bell published his Treatise on the Theory and Management of Ulcers. The minute divisions and subdivisions, the refinements and absurdities, respecting the nature of these lesions, are, with little variation, substantially reproduced by most of the practical writers of the present day. In studying the literature upon the subject, one is almost forced to conclude that, while every other branch of surgery has experienced the salutary influence of progress, this one alone has remained unimproved and uncared-for. I am, indeed, ready to admit that the nosography of ulcers is much more perfect now than it was formerly;

but who can read their classification, as it appears in most of our modern treatises, and not be struck with its many absurdities and inconsistencies? The catalogue is absolutely appalling, and it must be apparent to the most superficial observer that it comprehends, under different names, diseases which are absolutely and positively identical in their nature; not even constituting, strictly speaking, so many varieties, much less distinct species. Sir Astley Cooper, in his Lectures on the Principles and Practice of Surgery, describes not less than ten forms of ulcers, under the names, respectively, of healthy, languid, inflamed, gangrenous, irritable, sinuous, menstrual, varicose, ungual, and cutaneous, the latter including noli me tangere, and ulcers with thickened, inverted, and everted edges. A more recent foreign author, whose works were at one time extensively circulated in this country, adopts a somewhat similar arrangement. Thus, he treats, under so many separate heads, of the simple purulent or healthy, the weak, scrofulous, cachectic, indolent, irritable, inflamed, sloughing, phagedenic, and sloughing-phagedenic ulcer. The same spirit of classification pervades the works of more recent writers. Why, then, should it be deemed strange that the student should take up the investigation of the subject with doubt and misgiving as to his ability to comprehend it, even in the most superficial manner? No one, however industrious and intelligent, can possibly unravel the mysteries of divisions so minute and so utterly unphilosophical. It would puzzle the most profound pathological anatomist to discriminate between some of these classes of ulcers, as, for instance, between the irritable and inflamed, the sloughing and sloughing-phagedenic. To describe every sore that appears upon the body as a distinct ulcer because it happens to possess slight shades of differences in its external characters, would be as absurd as to describe, in a work on anthropology, every human being as a separate variety of the race because he happens to be a little unlike his neighbor. All inflammatory affections resemble each other, some closely, others remotely, but yet always sufficiently so to enable us to trace out their relations and affinities. The same is strictly true of ulcers; no two cases are ever precisely alike, and yet the most superficial observer may see that they exhibit many traits in common; one may be undermined, incrusted with aplastic matter, and the seat of severe pain, with a foul, sanious discharge, and great discoloration, heat, and swelling of the surrounding integuments; another may have hard and elevated edges, and a glossy, granulated surface, with, perhaps, scarcely any secretion at all, and none of the ordinary evidences of inflammation; in a third case the ulcer may be disposed to spread, its tendency being essentially destructive; in another series, by no means uncommon, the sore has thickened and everted edges, with profuse ichorous discharge, and an inability to furnish reparative material; finally, there may be a varicose state of the veins of the part, a sinus, disease of the adjacent bone, or disorder of the general system, modifying the action of the ulcer, and interfering with its cure. These are, it is true, contrarieties, but contrarieties which are solely dependent upon local and constitutional causes, and which, consequently, are not entitled to be considered as distinct diseases. We might as well say that the varieties of color in ordinary inflammation constituted so many reasons for founding new species of morbid action, when it is obvious that in this, as in the former case, the circumstance is purely accidental.

Assuming that all ulcers are merely so many forms of inflammation with breach of texture and more or less discharge, the most rational classification, it seems to me, that can be adopted, is that of ulcers into acute and chronic, according to the intensity and rapidity of the morbid action. Such an arrangement certainly greatly simplifies the subject, and divests it of much of the mystery and perplexity that have hitherto enshrouded it.

There are two genera of ulcers, just as there are two genera of inflammations, the common and the specific. Common ulcers are such as are produced by ordinary causes, as common inflammations, abrasions, and wounds; specific ulcers, on the contrary, owe their origin to the operation of some peculiar virus, as the poison of syphilis, smallpox, glanders, or malignant pustule. Although the ensuing remarks are more particularly intended to illustrate the various forms of common ulcers, they are also, at least in some degree, applicable to the specific, which, however, will receive special attention in their proper place.

1. ACUTE ULCERS.

The acute ulcer is distinguished by the rapidity of its progress, and the severity of its symptoms, which are those very much of ordinary acute inflammation. The sore usually

begins at a small point of skin, or skin and connective tissue, from which it speedily spreads in different directions until it often covers a large extent of surface. In its form it is generally somewhat oval or circular, but it is frequently very irregular, and instances are met with in which it is of a serpiginous, creeping, or angular shape. When the ulcerative action commences simultaneously at several spots, as occasionally happens, the sore may have a peculiar, sieve-like, or worm-eaten appearance, similar to that of the cover of an old book, or the bark of a tree. Its surface is red and angry-looking, either uniformly, or red at one point, and white at another, owing to the presence of aplastic matter, which occasionally overspreads it completely. When the action is unusually severe, the bottom of the ulcer generally exhibits a foul, greenish, brownish, or blackish appearance, and if, under such circumstances, any plasma is poured out, it is immediately spoiled or washed away by the discharges, which are always thin, sero-sanguinolent, and irritating, possessing none of the properties of laudable pus, such as is furnished by a granulating wound. In regard to the edges of this class of ulcers, they present the greatest possible variety; in general, however, they are thin, rather sharp, and somewhat undermined, or undermined at one place, straight at another, and perhaps everted at a third; in some cases they are very steep and ragged, notched or serrated. Extending from the sore in different directions are occasionally small sinuses or fistulous passages, which thus greatly complicate its character and protract the cure. The parts immediately around the ulcer exhibit all the phenomena of high inflammation, being of a deep red, livid, or purple color, preternaturally hot, painful, and more or less œdematous, from sero-plastic effusions.

The pain of the acute ulcer is frequently a prominent and absorbing symptom; it varies not only in degree but in character, being at one time throbbing or pulsatile, at another sharp or pricking, at another dull, heavy, and gnawing. Its violence is often altogether disproportionate to the extent of the morbid action. Cases have often been under my observation in which, although the ulcer was scarcely as large as a twenty-five cent piece, the pain was so excruciating as to deprive the patient of sleep for days and nights together, and bring on rapid emaciation and hectic irritation. It may be limited to the sore, but in general it is felt over the whole of the inflamed surface, and is usually worst at night and in damp states of the atmosphere. Posture also commonly aggravates it, being more severe when the part is dependent than when it is elevated, although occasionally the reverse is true, even when the sore is quite large.

Along with these phenomena there is generally considerable constitutional derangement, manifesting itself, not so much in febrile commotion, as in an irritable state of the system, and in disorder of the digestive organs. The patient feels unwell rather than sick; his head troubles him; his appetite is vitiated, or temporarily arrested; the tongue is coated, and there is a bad taste in the mouth, especially in the morning; the bowels are inclined to be constipated; and the urine is scanty and high-colored. When the ulcerative action is rapid and extensive, there is frequently more or less fever, with thirst, restlessness, loss of sleep, and excitement of the pulse. Disorder of the secretions is generally a prominent symptom in these cases, especially of the liver, uterus, and mucous follicles.

An impoverished state of the blood, however induced, habitual intemperance, excessive indulgence at table, mental anxiety, exposure to cold, and the various eruptive diseases, may be enumerated as so many predisposing causes of the acute ulcer. Nervous, irritable, and plethoric persons, especially old dram drinkers, are its most frequent subjects. Both sexes are liable to it; but men, from their greater exposure and hardships, suffer much more frequently than women. It is rarely met with in the higher circles of society, and in very early life.

An ulcer may be acute from the beginning, or it may suddenly become so after having been, perhaps, for months or even years in a dormant condition with, it may be, little disposition either to advance or to recede. However this may be, the disease often spreads with astonishing rapidity, eating away everything within its reach—skin, connective tissue, fibrous membrane, muscle, and sometimes even bone—and often laying waste in a few days an extent of surface which it may take months, aided by the best skill, to repair. When this is the case, the action may be said to be truly phagedenic, or to consist of rapid mortification of the molecular structure of the suffering part, which is hot, œdematous, fiery red, exquisitely painful, and bathed with profuse, fetid discharges. Constitutional disturbance is great, and the tendency is usually decidedly typhoid, especially if the patient has been worn out by intemperance and other causes of depression. This form of ulcer is very prone to occur upon new and imperfectly organized skin, where it often commits the most terrible ravages, which, for a time, hardly anything can successfully resist.

Treatment.—The treatment of the acute ulcer must be strictly antiphlogistic, modified, of course, by the peculiar exigencies of the case. When the symptoms are urgent, as denoted by the severity of the local and constitutional disorder, the indication obviously is to take blood from the arm, provided the patient is at all plethoric; or, this not being permissible, at all events to open his bowels freely with an active cathartic, containing from five to ten grains of calomel, and followed up, if necessary, in six or eight hours, by infusion of senna and sulphate of magnesium. Recourse is then had to the antimonial and saline mixture to subdue vascular action; while opium is administered in large doses to allay pain and induce sleep. The diet must be mild and not too nutritious, and the patient must observe the most perfect rest in the recumbent posture. Active purgation will be found to be of the greatest value in this form of ulcer; in fact, it is difficult to imagine a case in which it could be entirely dispensed with. To render it promptly effective, however, I have long been in the habit of combining with it a certain quantity of mercury, either in the form of calomel, or blue mass, with a view of making a strong and rapid impression upon the secretions, which, as before stated, are usually notably deranged, and which thus keep up a spreading tendency in the disease. Of the beneficial effects of anodynes in arresting acute ulceration no one, who has witnessed them, can form any just conception. Their salutary impression is evidently due to the influence which they exert in tranquillizing the heart's action, and in allaying nervous irritability, which is generally so prominent a symptom in this affection; hence they should always be given in large and sustained doses from the very commencement of the malady.

It is not to be inferred from these remarks that active depletion is suited to all cases of this disease; on the contrary, we are often obliged to use tonics and stimulants at the very beginning of the treatment, and to continue their exhibition until we have succeeded in building up the system, so as to enable it to oppose a successful barrier to the encroachment of the morbid action. The state of the pulse, skin, digestive organs, and muscular system will generally serve as a correct guide to the kind of treatment best adapted to meet the exigencies of this class of cases. Quinine, iron, and milk-punch, with opium, or the salts of morphia, will usually constitute the most reliable means.

The local treatment does not differ, in its general principles, from that already described as applicable to acute inflammation, except as it respects the modifications arising from the presence of a broken surface. The part, as a primary and essential step, must be placed perfectly at rest in an easy, elevated position, to prevent arterial ingress and favor venous return; it will even be well, in many cases, to lay the limb upon an inclined plane, so that the sore shall be higher than the rest of the body, and to confine it, if necessary, in this situation by means of a light roller, applied in such a manner as not to obstruct discharge or make undue compression. If the part be filthy from want of cleanliness, or adherent dressings, ablution by immersion should precede direct medication. The use of leeches is commonly objectionable, however high the inflammation, for the reason that the bites of these animals are liable to occasion excessive pain, and sometimes even an aggravation of the disease. A much better plan is to draw blood by scarification with the lancet, the limb, firmly encircled with a cord a few inches below the knee, the while standing in a tub of warm water. From six to a dozen vertical incisions, not quite skin deep, being made over the inflamed surface around the sore, the blood is permitted to flow until the patient shows signs of approaching syncope, if he be at all plethoric, or, at all events, until the engorged vessels have been thoroughly unloaded, as denoted by the comparative pallor of the part. There is no method so well adapted as this to make a prompt and decided impression upon an acute ulcer; it is a most potent alterant, and I rarely omit its employment in any case of the slightest urgency. For the sore itself the best remedy is the officinal solution of acid nitrate of mercury, diluted with eight, ten, or fifteen parts of water, according to the foulness of the affected surface. The application should be made lightly with a soft sponge or a cloth mop, and may, if necessary, be repeated once in the twenty-four hours until there is a manifest improvement in the condition of the ulcer, when it should be entirely dispensed with, or used much weaker and more sparingly. Another valuable agent is carbolic acid; and now and then great benefit accrues from the use of chloride of zinc. As a constant covering for the parts, the most suitable one is a light emollient cataplasm, or warm water-dressing medicated with acetate of lead and laudanum, the latter being used warily, especially if the exposed surface be uncommonly large. Fetor is allayed with the chlorides. In some instances yeast may advantageously be added to the poultice. Under this treatment rapid improvement may usually be looked for; the ulceration soon assumes a more healthy character; the discharges become thicker and less profuse; the surrounding parts lose their fiery red and

œdematous aspect; and as the reparative process advances granulations spring up, and new skin forms along the margin of the old. When that point has been attained none but the mildest applications will be needed.

Such, in a few words, is an outline of the treatment which, when a choice of remedies is allowed, will generally be found to be most serviceable in this class of ulcers. But the patient will not always submit to scarification, nor is this always proper, owing to the exhausted condition of his system. Under such circumstances, the object may often be promptly attained by the free application of the dilute tincture of iodine to the parts around the sore, while the sore itself is lightly touched with the acid nitrate of mercury, as in the previous case, or with a strong solution of nitrate of silver or this article in substance, although both are decidedly inferior to the former remedy. In some instances a speedy and permanent check may be put to the ulcerative action by covering the sore and the inflamed surface with a blister, retained until thorough vesication is induced, followed by the ordinary dressings. Few cases of acute ulcers can resist this remedy. Its beneficial effects are no doubt due to the drainage which it establishes, and the consequent change in the action of the capillary vessels. The progress of the cure is sometimes embarrassed by dead matter, as shreds of connective tissue and fibrous membrane, the removal of which should receive prompt attention.

2. CHRONIC ULCERS.

While it is not always easy to determine when an ulcer becomes chronic, it is to be borne in mind, as was previously stated, that a chronic ulcer may, in consequence of local and constitutional causes, occasionally assume an acute character. In this respect the present disease does not differ from ordinary inflammation, unattended by breach of texture. Thus, an inflammation of the conjunctiva, after having pursued a chronic march, with but little pain and discoloration, perhaps suddenly, at the end of several months, breaks out with renewed vigor, characterized by all its primitive intensity, and now rapidly urging on the affected structures to permanent disorganization, rendered the more prone to this occurrence by their protracted suffering. Ulcers are not unfrequently subjected to similar hardships; not once only, but, perhaps, many times during their progress, and thus their career often becomes a most checkered one, defying alike our powers of diagnosis and treatment, and constituting at least one of the causes, previously adverted to, of the unscientific nomenclature which disfigures this branch of surgery.

When does an ulcer become chronic? or, in other words, what time must elapse before it can be said to assume this character? To this question it is impossible to give anything like a definite reply: in some instances the disease is chronic almost from the beginning; in others, it becomes so in a few weeks; and in others, again, perhaps several months intervene. The term chronic, as every one knows, has reference to time, and is employed to designate a class of affections which, having passed through their acute stages, are deprived of their primitive characteristics; their action has been modified by treatment, or by treatment and the operation of time. The inflammation now generally exists in a much milder form; there is less functional disturbance, while the constitutional derangement often entirely ceases, and the local phenomena of heat, redness, pain, and swelling are materially diminished in intensity. The part, however, is oppressed, if not overpowered, by effused fluids; its vessels are sluggish, dilated, and engorged with dark blood; nervous sensibility is perverted, and the restorative tendency is either much embarrassed or completely at a stand. Ulceration still goes on, and, perhaps, commits even serious havoc, but the action is tardy, and exhibits few, if any, of the phenomena which originally characterized it. It would seem, at first sight, as if it were a paradox to say that a disease was chronic from its commencement, and yet such is, nevertheless, the fact; rather, however, in reference to its symptoms than to the true and legitimate meaning of the term.

Chronic ulcers often exist for many months and years together; at one time stationary, now receding, now advancing; in one case exhibiting too much action, in another too little, but rarely in a condition to furnish the requisite amount and quality of reparative material. Even if granulations occasionally do form, they are seldom healthy, or, if healthy, they seldom long remain so; on the contrary, they soon languish for the want of proper support, or they perish from the violence of the attendant inflammation. These effects may be the result purely of local causes or of causes exerting their influence indirectly through the constitution; generally, perhaps, of both. If this statement be true, as multiplied observation proves, we cannot fail to deduce from it important principles of

practice. It plainly suggests the necessity, in every instance, of a careful inquiry into the nature of the exciting cause and the condition of the system, as well as the state of the part itself. To treat a chronic ulcer upon any other plan is a palpable absurdity; and yet that this is generally the case, daily experience amply attests. Few practitioners look upon this class of diseases in their true light; their ideas of their pathology are vague and indistinct; and it is, therefore, not surprising that they find themselves so often and so completely baffled in their efforts to cure them. It is for this reason that chronic ulcers of the legs have so long been regarded as an opprobrium of surgery, and that so many patients are obliged to carry their malady with them to the grave, notwithstanding the numerous attempts that may have been made to get rid of it; all arising from the fact that its true nature was never properly understood.

The chronic ulcer is capable of assuming every possible variety of seat, number, form, size, color, condition of surface, and complication. In general, it occupies the inner surface of the leg, a few inches above the ankle; but it is often situated higher up, and in rare cases it lies directly over the joint itself. The outer surface of the limb is also liable to suffer, and occasionally both sides are affected simultaneously. In fact, no part of the leg is wholly exempt from the disease, unless it be that just below the knee. The remarkable liability of the inner and lower part of the leg to the occurrence of ulcers seems to be due, in a great degree, if not wholly to the delicacy of the skin in this situation, and the very liberal supply of veins, thus rendering the tissues prone to congestion, a condition still further favored by the erect posture and by the artificial constriction of the limb, from the habitual use of the garter.

The form of the ulcer is variable, being at one time circular, now oval, and then angular, or so irregular as to defy all attempts at accuracy of description. In some cases, it extends round the limb in the form of a belt nearly of equal width. In size it ranges from a five-cent piece to that of the palm of the hand, or even the entire hand, the destruction of substance being truly frightful. In its depth, it rarely reaches beyond the subcutaneous connective tissue; in some cases, however, it involves the aponeuroses, the muscles, and even the bones and cartilages. Such ravages generally imply an unusual amount of antecedent inflammation, or the repeated intervention of acute action, although they are often produced by the steady progress of the chronic disease itself.

Although the chronic ulcer is often solitary, it is not uncommon to meet with two, three, or even a larger number, situated either in close proximity with each other, or at different, and perhaps rather remote, points of the limb. When the number is considerable, their size is usually proportionately small.

The color of the ulcer varies from light rose to deep purple, according to the intensity of the concomitant action and the congested condition of the cutaneous capillaries. The most common shades of color are the dusky, brownish, and light livid,

Fig. 21.

Chronic Ulcer with Deep Edges, partially undermined, and a Foul, Unhealthy Bottom, studded with Fungous Granulations.

but it is worthy of note that an ulcer which is of a rosy hue to-day may be of a deep purple to-morrow, simply from the change in its inflammatory condition. The parts around the sore are often as high-colored as the sore itself; sometimes, indeed, much more so. In general, the discoloration, of whatever character, is lost by insensible gradations in the surrounding healthy hue, not abruptly, as in erysipelas and erythema.

In regard to the edges of the chronic ulcer, nothing can be more diversified; hence, some of those singular distinctions of Home, Astley Cooper, and others who have followed so closely in each other's footsteps. In general, the edges are hard or callous, elevated, rather broad, and so insensible as to admit of the rudest manipulation: in some cases, they are thin, ragged, almost serrated, and either everted or inverted, and perhaps exquisitely sensitive. In another class of cases, by no means infrequent, they are considerably undermined, or shelving at one point and everted at another. In fact, there is no end to the diversities presented by the boundaries of such a sore.

The surface of the ulcer is generally more or less irregular, being deeper at one part than at another, although, as was before stated, it rarely extends beneath the subcutaneous connective tissue. Its actual condition usually varies with the amount of inflammatory action. When this is considerable, there is often an entire absence of granulations, and then the bottom of the sore will generally be found to be in a foul, bloody, or phagedenic condition, or incrusted with a stratum of lymph too feeble to admit of organization; or, finally, granulations, sloughy matter, and vitiated plasma may all be present, in varying degrees, upon different parts of the exposed surface. The concomitant discharge is profuse, sanious, fetid, and irritating, possessing none of the properties of laudable pus. The sore, as well as the surface immediately around it, is usually sensitive, and often the seat of severe pain. It is to this form of ulcer that writers usually apply the term inflamed, or irritable, from its excess of vascular and nervous activity. It is most common in nervous, irritable subjects, and in the habitually intemperate.

When the inflammation is more moderate, granulations are seldom wholly absent, and they may exist even in great abundance, although they may be altogether unhealthy. When the action is somewhat less, but not too languid, they commonly exhibit a pale, reddish, flabby appearance; their surface is irregular or tuberculated, and they are much too large; in fact, they look as if they had been reared in a hot-bed and had been too freely watered. Their reparative power is so very feeble that the surgeon is often obliged to get rid of them entirely before a cure can be effected. This state of granulation constitutes what is vulgarly called "proud flesh," and is often difficult to manage.

Again, the circulation may be inordinately languid, and then the granulations may be still larger, totally insensible, and perhaps quite œdematous, readily pitting under pressure, and, if punctured, freely exuding a serous, sanious, or ichorous fluid. Cacoplastic lymph is generally interspersed through the granulations, or adherent to the surface of the sore, the edges of which are hard and very prominent, so that the raw surface appears as if it were much below the level of the surrounding parts, which, however, it seldom is. The accompanying discharge is slight, thin, and sero-sanguinolent; while the adjoining skin is œdematous and of a dusky-brownish hue.

Finally, cases occur in which the granulations are very small, or apparently stunted in their growth, irregular in shape, of a fiery red color, and so exquisitely sensitive as to be a source of great suffering, the ulcer being intolerant of the slightest pressure, motion, or manipulation; the discharge is sanious and irritating, although seldom very fetid or profuse; the edges of the sore are thin, irregular, everted, or inverted; and the surrounding skin is actively inflamed.

The chronic ulcer is often complicated with other diseases, which tend to modify its action, and impede, if not entirely prevent, its restoration. Of these affections some are of a local, others of a general character. The former consists mainly in the involvement of the deep-seated structures, as the fibrous membranes, tendons, muscles, and bones; in the formation of sinuses; in a varicose state of the veins; and in the presence of foreign matter, under the influence of which the ulcer was, perhaps, originally induced. Eczema of the skin around the ulcer is often met with, especially in cases of long standing in elderly subjects, addicted to intemperance, overfeeding, or habitual constipation of the bowels, and is generally a source of great discomfort, if not actual suffering. The eruption usually appears in patches, studded with little vesicles, resting upon a reddish, bluish, or bronze colored base, and attended with more or less itching.

Old ulcers, especially if habitually irritated, occasionally, although rarely, become the seat of carcinomatous disease, the most common form being the epithelial. Such a change may occur in almost any part of the body, but is most frequently met with in the legs of old, dilapidated subjects.

Spots, of variable form, size, and color, often exist upon the skin in the neighborhood of chronic ulcers, and are generally an index of a degraded, depressed, or impaired action occurring most commonly on the inner side of the leg; they are of a dark purple, grayish, black, bronze, or brownish hue, are longer in the perpendicular than in the transverse direction, and are obviously dependent upon some change in the pigmentary structure of the skin. In some instances the color is pretty uniform, and involves nearly the entire circumference of the limb, forming a belt perhaps several inches in height. It is worthy of note that this pigmentary change is very often associated with a varicose condition of the veins.

Among the constitutional complications, the most common are, disorder of the secretions, especially of the liver and alimentary canal, anemia, dyspepsia, plethora, and habitual intemperance in eating and drinking. I have never seen what writers have

called the menstrual ulcer, although it is not to be doubted that great uterine derangement, showing itself in deficiency of discharge, might seriously interfere with the healing of a sore on the leg, or, indeed, on any other part of the body. An ulcer is sometimes rendered exceedingly sensitive and irritable by a gouty or rheumatic state of the system.

Treatment.—In the management of chronic ulcers the leading indications are, first, to remove any complications that may exist; secondly, to regulate the inflammatory action; and, lastly, to produce healthy granulations. If these cardinal points be kept in view, the practitioner cannot fail to settle down upon a rational and philosophical plan of treatment, destined to be crowned with success. It is only necessary to treat the disease as one of ordinary inflammation, modified by accidental circumstances. The great object in every case is to bring the ulcer into a simple granulating condition, so as to afford nature an opportunity of beginning and carrying on the healing process without impediment.

Ulcers sometimes refuse to heal in consequence of the partial destruction of aponeurotic, tendinous, or muscular tissue, or the manner in which the parts are compressed by overlying structures; in the former case, the dead substance is removed with the knife or scissors; in the latter, relief is afforded by adequate incisions, after which the malady is treated upon general principles. Necrosed bone is extracted with the forceps, while carious bone is scraped away, or removed with the chisel, gouge, saw, or scalpel.

Varicose veins are dealt with according to the rules laid down for the management of that disease in a subsequent chapter: the complication is often a serious one, and nothing short of the ligation of the affected vessels, or their destruction with Vienna paste, answers the purpose. When the malady is comparatively slight, amelioration may be afforded by wearing an elastic stocking to give uniform support to the limb, and by the free use of spirituous lotions, with the occasional application along the track of the enlarged vessels of dilute tincture of iodine. Hemorrhage sometimes attends this complication, from extension of the ulceration into a contiguous vein: I have seen cases where more than a quart of blood was thus lost in a few minutes, and I am cognizant of two instances in which the bleeding was so copious as to prove fatal. The proper remedy is compression, followed, if need be, by a Vienna paste issue to produce permanent obliteration of the vessel at the seat of the ulceration.

Sinuses are laid open with the director and bistoury, their course being completely traced out, as no cure is to be expected so long as any portion remains concealed. Reunion of the incision is opposed by the tent and by careful dressing.

Ulcers, consequent upon wounds, are frequently prevented from closing by the presence of foreign matter, as a pellet of paper, a piece of cloth, a ball, nail, or fragment of bone. In such an event, a careful search is made with the probe, and the substance, if detected, is extracted in the usual manner.

In an ulcer attended with undermined, inverted, ragged, or very callous edges, the proper plan is to use the knife, cutting off all that is spoiled, redundant, or irreclaimable. Exuberant granulations are similarly dealt with, excision here being far preferable to escharotics, the action of which is always painful, tedious, and uncertain.

Ulcers complicated with hemorrhage are treated upon general principles. The blood may proceed from an artery or vein, laid open by the morbid action, or it may ooze from numerous points, as when there is a dissolved state of the blood, or a hemorrhagic diathesis. In what English surgeons call the menstrual ulcer, the discharge is generally vicarious of, and consequently coincident with, the menstrual flux, and usually readily disappears under tonic treatment, as iron and quinine, with exercise in the open air, saltbathing, and other invigorating measures.

The second object is to reduce the concomitant inflammation, in order to enable the sore to form healthy granulations, which it cannot do so long as the morbid action is either very high or very low. One step towards accomplishing this end is the removal of complications, which, indeed, is frequently of itself sufficient to effect a cure. When this fails, the rest of the inflammation is often readily relieved by the application of dilute tincture of iodine to the parts immediately around the ulcer, preceded, when the congestion and discoloration are unusually great, by free scarification; and by touching the sore itself very gently, once a day, with solid nitrate of silver, or, what is better, the officinal solution of acid nitrate of mercury, variously weakened, according to the exigencies of the case. One such application in the twenty-four hours usually suffices, and in many instances the cure will progress more rapidly and satisfactorily if it be made less frequently. Other topical remedies may often be advantageously used, especially the nitric acid lotion, and solutions of acetate of lead and opium. As a constant protection for the parts, nothing is more suitable than an elm or a linseed cataplasm, which, notwithstanding

the abuse that has been heaped upon it, is still, in most cases, one of the neatest and most trustworthy remedies. Or, instead of a poultice, warm water-dressing may be used, medicated, when the pain is very great, with solutions of morphia, or morphia may be cautiously sprinkled directly upon the surface of the ulcer.

When the healing process is impeded by the indurated, disorganized, and contracted condition of the tissues immediately around the ulcer, there is no method of treatment so likely to be beneficial as the one originally suggested by Mr. John Gay, of London, consisting in the thorough division of the parts by drawing the knife elliptically through the skin, connective tissue, and aponeurosis a short distance from the sore, thus severing their adhesions, and changing their action; in other words, placing them under entirely new relations. The operation is often quite bloody, especially when it involves, as it occasionally does, large veins; but the flow, which is usually productive of great benefit by relieving the engorged vessels, is always easily controlled by means of styptics and compression.

Whatever local measures be adopted, strict attention must be paid to the state of the system; the bowels must occasionally be relieved with mild aperients, and care must be taken that the diet is perfectly mild and not too nutritious. If the general health is much disordered, recourse is had to more active purgation, and to the free use of antimonial and saline medicines, with a full opiate at night, especially if there be much pain, or inability to sleep. Bleeding at the arm will be required only in very plethoric subjects, in urgent cases. When an ulcer is associated with a gouty or rheumatic state of the system, the use of colchicum, salicylic acid, and other suitable remedies is indicated. Absolute recumbency is observed, at least until the morbid action has been measurably subdued; and the affected part is placed at rest in an easy, elevated position, precisely as in ordinary inflammation.

If the general health is much reduced by protracted suffering, or if the system is in an anemic condition, or, finally, if typhoid symptoms are present, stimulants and tonics will be indicated, especially quinine and iron, with milk-punch, nutritious food, and change of air.

If the measures now detailed be judiciously employed, the ulcer will soon be placed in a suitable condition for the development of healthy granulations, fig. 22, after which little else will be necessary than to watch the parts, with a view to the prevention of overaction.

Fig. 22.
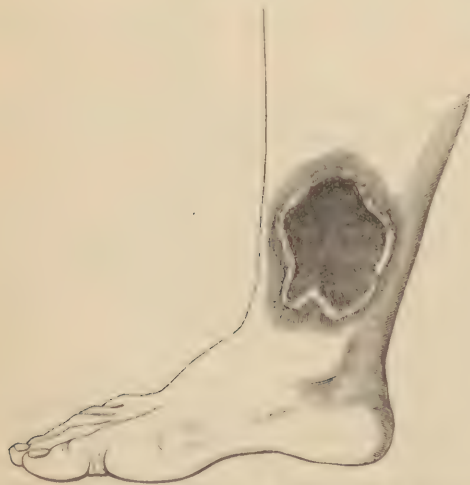
Granulating Ulcer, beginning to Cicatrize; the Process extending from the Periphery towards the Centre.

The mildest and most soothing applications will now generally suffice, the object being rather to protect the surface of the sore from the injurious contact of the atmosphere than to promote its welfare by direct medication. Among the best of these remedies are ointments prepared with opium, acetate of lead, balsam of Peru, oxide of zinc, and above all, the ointment of the acid nitrate of mercury, diluted with ten to twelve times its weight of cosmoline. Its cicatrizing properties are far greater than those of any other substance I am acquainted with. When the ulcer is very sensitive or irritable, iodoform or chloral may be used, either in a solution or in the form of unguent. Iodoform rendered odorless by admixture with oil of aniseed is sometimes highly serviceable in the treatment of the more obstinate form of old ulcers. It should be applied in a thick layer, the sore being previously well cleansed and dried, and afterwards carefully strapped with soap and mercurial plaster, daily renewed. Any disorganized matter should be thoroughly scraped away, as a preliminary step, to promote the development of healthy granulations. The scabbing process may often be expedited by touching the granulations very lightly, once a day, along the edge of the sore, for the space of a line, with solid nitrate of silver.

Rest in the treatment of ulcers is indispensable to a rapid cure, and yet instances constantly occur where, either on account of the patient's condition in life, or the exhausted state of his health, exercise in the open air is absolutely necessary; under these

circumstances, the part should be as carefully protected as the exigencies of the case will permit, fatigue and protracted dependency being especially guarded against. The bandage in particular will usually be found to be a powerful adjuvant both to comfort and cure ; but it must be applied equably from the distal portion of the limb upwards, and not in folds or creases, otherwise it will do infinite harm. It must be changed at least once a day, being replaced as soon as the limb has been thoroughly cleansed and the sore properly dressed. In hot weather, it may occasionally be kept constantly wet, with good effect, with cold water, spirituous lotions, or weak solutions of lead and opium. In winter the " domette " flannel bandage is preferable to the ordinary roller, as it is both warmer and more elastic.

A most important step was made a few years ago, in the treatment of chronic ulcers by the use of the elastic bandage, originally recommended by Dr. Henry A. Martin, of Boston. It is particularly applicable to the treatment of old ulcers attended with varicose enlargement of the veins, or an eczematous condition of the skin, and is far superior to the treatment by the ordinary roller and Baynton's dressing, so long in vogue in such cases in this and other countries. The plan consists in enveloping the affected limb in what is known as the solid rubber bandage, applied spirally from near the toes upwards in such a manner as to afford firm and equable support to the parts. The bandage, which should be about two inches and a quarter in width by ten to twelve feet in length, and furnished at the upper end with two tapes for fastening, is removed every night, washed, and reapplied in the morning, the sore and the surrounding surface having been previously well cleansed with soap and water. No protective is placed upon the ulcer, unless, as occasionally happens, the bandage acts for a while as an irritant, when the interposition of a piece of gauze or of thin patent lint may become necessary. The bandage during the first few days is generally productive of some inconvenience, caused by the increased heat and the confinement of the secretions ; but this soon subsides, and is followed by so much relief that the patient would be unwilling to go without it even for a day. In some cases, especially in persons of delicate skin, a few vesicles or even pustules are liable to form, and the epidermis is apt to become so much softened and macerated as to give rise to disagreeable feelings. The same bandage can often be worn for months, and even years, and is therefore a great desideratum with poor patients, who are thus enabled to perform their daily labor with entire comfort. If, at any time, the sore becomes inflamed, it may be covered with a poultice at night. The bandage should always, if possible, be reapplied before the patient leaves his bed, and, consequently, before the veins become distended with blood.

The method of Baynton sometimes furnishes very good results, especially in small ulcers attended with great thickening and induration of the skin. It consists in strapping the sore and adjacent parts with adhesive plaster cut into strips, varing from an inch to an inch and a quarter in width, and long enough to extend about three-fourths around the limb, each one being so arranged as to overlap that which is below it, and drawn so firmly as to afford uniform support to the affected surface, as in fig. 23. The dressing, which is completed by enveloping the limb in a bandage from the toes as high up as the knee, should not be changed, on an average, oftener than twice a week. Occasionally, as when the ulcer is associated with a varicose state of the veins of the extremity, the entire foot and leg may be beneficially enveloped with adhesive plaster for some distance above the sore, as originally suggested by Mr. Critchett. In my own practice I have often found that the mere covering of old, granulating ulcers with adhesive plaster, by protecting them from the air and the friction of the clothing, is highly favorable to their cicatrization.

Fig. 23.

Mode of Strapping of an Indolent Ulcer.

In cases of long standing, the surface of the ulcer may sometimes be advantageously protected with an artificial crust, consisting of an ointment composed of three parts of prepared chalk and two of fresh lard, the former being previously reduced to a very fine

powder, and then gradually stirred into the latter, melted in a vessel over a slow fire. The ointment is applied once a day upon a piece of lint, and the limb is supported either with Baynton's dressing, or a flannel bandage, as suggested by Mr. J. K. Spender, the author of this mode of treatment.

A powerful impression may generally be made upon an atonic or indolent ulcer even in a few days by the use of galvanism. The current is transmitted through a copper wire from six to eight inches in length to a thin silver plate, of suitable size and shape, applied to the sore, and connected with a small zinc plate placed upon the sound skin a short distance off, a piece of chamois leather, soft sponge, or paper lint, moistened with vinegar, intervening. The apparatus is held in position by a bandage or by adhesive strips. Under the stimulus thus produced, healthy granulations are rapidly developed, with a strong tendency to cicatrization.

There is great art in dressing an ulcer. Everything like rude manipulation and protracted exposure must be avoided; the sore is never wiped, or even touched with the finger, and, while the necessary ablutions are going on, the limb is carefully supported over a basin or small tub, the water, which may be either cold or tepid, being gently squeezed upon it from a sponge held at a distance of several inches. The secretions being thus disposed of, the surrounding surface is properly dried, and the dressing reapplied. If fetor be present, a little permanganate of potassium, chlorinated sodium, or carbolic acid is mixed with the water employed in cleansing the sore, as well as sprinkled from time to time upon the poultice and bandage. When the discharge is unusally abundant, oakum may be advantageously used to absorb the matter. The eczema so liable to complicate old ulcers of the leg is generally promptly relieved by a brisk laxative, a cooling diet, and the application of benzoated zinc ointment, or dilute ointment of acid nitrate of mercury. If much inflammation be present, a weak solution of actetate of lead will be the most suitable remedy.

The cicatrization of ulcers, as will be shown in another chapter, is often greatly promoted by skin-grafting, or by the insertion of little bits of integument into different parts of the affected surface. To insure the success of the operation, it is essential that the sore, as well as the adjacent skin, should be as free as possible from inflammation, that the granulations should be of a healthy, florid complexion, and that the discharge should possess all the properties of what is called laudable pus. When these characteristics are present, it is an evidence that both the part and the system are in a good, sound condition, and that skin-grafting may be performed with every prospect of expediting the healing of the sore by establishing more or less numerous centres for the formation of a new skin.

Whatever mode of treatment be employed, it is essential, as it respects the prevention of relapse, that the patient should observe great care in regard to his exercise and diet, for a number of weeks after the ulcer has completely healed. If he indulges his appetite too soon, neglects his bowels, or allows his secretions to become disordered, he can hardly escape a new outbreak of the disease, especially if, at the same time, he fatigues his leg much, lets it hang down constantly, constricts it improperly with his garter, rubs it with his boot, or permits it to become covered with filth. Cleanliness, indeed, cannot be too rigidly enforced as a means of promoting healthy action. The parts should be thoroughly washed at least once a day with soap and water, and then sponged with some alcoholic lotion, to revive and invigorate their exhausted powers.

In inveterate cases, extensively involving the osseous tissue, greatly impairing the general health, and resisting the best efforts of the surgeon for their relief, the only resource is amputation, performed through a sound portion of the limb. Such a procedure, however, will, I am sure, be rarely demanded in these days of conservative surgery; for, unless the bone is almost entirely destroyed, it will be easy, in the majority of instances, to dispose of the diseased structures with the knife, gouge, and mallet, or by resection.

Finally, the question may be asked, is it always safe and proper to heal old ulcers? Upon this subject, various opinions have been expressed by writers on surgery. Those who assert that it is not, assume that such sores act as issues, which serve as safety-valves to the system, by ridding it of redundant, if not positively peccant, humors. They allege that cerebral apoplexy and other serious diseases have occasionally occurred as the direct and speedy consequences of the drying up of old ulcers. Those, on the contrary, who espouse the opposite side of the question, declare that such attacks are mere accidental circumstances, readily explicable by the laws of coincidence; a view which I have myself always adopted. It is questionable, indeed, whether surgical science possesses any well-authenticated facts by which this opinion can be sustained. I have often cured ulcers of five, ten, and even fifteen years' standing, constantly attended with more or less discharge and

irritation, and yet no instance to which such an event could justly be ascribed has ever fallen under my notice. Besides, the constitutional treatment that is usually necessary in these cases to effect relief, is, in itself, almost a guarantee against attacks of grave disease in other parts of the body. If, however, such an occurrence should be dreaded, it would be easy, while the sore is drying up, to protect the system by a continuance of the constitutional remedies, especially a spare diet, and the occasional use of a purgative, conjoined with the employment of an issue in a remote region of the body, as the arm, chest, or neck.

SEC. X.—GRANULATION.

Granulation is the means by which lost tissues are replaced and wounds healed when they fail to unite by the first intention, or by adhesive action. The process is one of great interest, whether it be viewed merely as a physiological phenomenon, or as an operation employed by the system to restore injured and mutilated structures. An intimate knowledge of its nature and habits is, therefore, of great importance to the surgeon.

It is chiefly upon the external surface of the body that an opportunity is afforded of examining this process with any degree of satisfaction. In the various mucous outlets it is more difficult to watch and to trace it through its different stages; while in the internal organs it either does not occur at all, or is observable only after death.

It may be assumed, as a law, that high vascular excitement and repair are incompatible with each other. Hence, before the process in question can fairly begin, there must be a material abatement of the inflammation. As soon as the balance of action has thus been reëstablished, the breach is covered with red, fleshy-looking bodies, technically denominated granulations. By a continuance of this action the developmental process steadily progresses until the gap is finally filled up and scabbed over.

A granulation is a highly organized body, capable of executing highly important functions. It consists essentially of capillary vessels, the interstices of which are occupied by small, soft, round, nucleated, embryonic cells, heaped upon each other without any particular order, and connected together by a minute quantity of amorphous, mucous intercellular substance. It is usually of a florid color, very vascular, extremely sensitive, and of a conical, rounded, or oval shape, its volume varying from a mustard-seed to that of a large shot. Its vessels, which are remarkably numerous, are evidently, for the most part, outgrowths of those of the adjacent parts, and are arranged, as seen in fig. 24, from Billroth, in the form of beautiful loops and arches, closely interwoven with each other. As they are developed with great rapidity, their walls are at first so extremely delicate as to yield to the slightest pressure; hence there is generally more or less hemorrhage whenever anything is rudely brought in contact with them. The veins are very large, tortuous, and convoluted.

Fig. 24.

Bloodvessels in Granulations.

Although no nerves are demonstrable in granulations, they are unquestionably abundantly supplied with them, as is shown by the fact that they are often very sensitive, especially when diseased. The existence of lymphatic vessels also is a matter of inference rather than of positive proof. Observation shows that certain articles, placed in contact with a granulating ulcer, are promptly taken up, and carried into the system, producing a similar effect, nearly in as short a time, as when introduced in the ordinary manner. Thus, morphia readily allays pain and induces sleep; atropia dilates the pupil; arsenic irritates and inflames the stomach; strychnia convulses the muscles. Moreover, a granulation is a secreting body, a kind of compound gland, capable of pouring out plasma and providing the elements of pus; the former for enlarging its own dimensions and multiplying itself; the latter as a means of defence from the atmosphere and the surgeon's dressings.

Granulations form with various degrees of facility, depending mainly upon the nature of the part and the amount of inflammatory action. Ulcers of the skin and connective tissue always, other things being equal, furnish them most readily, as well as in greatest abundance; a circumstance evidently due to their extreme vascularity and high nervous endowment. Bone, cartilage, tendon, and fibrous membrane, on the contrary, granulate more slowly, and hence injuries of these structures are always repaired with more difficulty. The same rank applies, only more pointedly, to scirrhous and other malignant ulcers.

The bodies are sometimes developed subcutaneously. Paget states that he has seen a mass of florid granulations in a case of simple fracture, in which the ends of the bones had remained long ununited, and a similar phenomenon is occasionally witnessed in Pott's disease of the spine. In a case of caries of the ribs and costal cartilages in a young man, I found the bottom of the ulcer studded with numerous fine, florid granulations, although the opening in the skin, hardly the size of a common probe, was nearly three inches distant; and in a case of hematoma of the burse of the patella in a young woman, a patient at the College clinic, I found, after the semiorganized clots were scraped away, numerous well-formed bodies of a similar kind upon the walls of the cyst, the overlying integument being perfectly healthy.

In examining a cluster of granulations, a great difference may generally be observed in their character. The deep-seated ones are comparatively firm, more or less elongated, and of a fibroplastic structure, if not actually filamentous. The superficial, on the contrary, are in a rudimentary state, very soft, lacerable, and extremely vascular. At the edges of the surface, near the junction of the new and the old tissues, they possess the properties of incipient epithelial cells.

Granulations are liable to disease. This often occurs from causes apparently the most insignificant; depending, perhaps, at one time upon the state of the part, at another upon the state of the constitution, or upon both combined, but more frequently upon the nature of the dressing, and the indiscretion of the patient. Hence, the appearance of these bodies usually serves as an index of the concomitant action, local and general, and affords useful indications of treatment. The most important alterations which they undergo are such as relate to their size, color, consistence, and sensibility. Healthy granulations are generally small, not exceeding the volume of a mustard seed, but cases occur in which they are many times larger. Their natural color is a beautiful florid; when congested or inflamed they assume a purple, livid, or brownish aspect, while under opposite states they are occasionally pale, or even blanched. In their consistence these bodies may, on the one hand, be very soft and lacerable, and, on the other, very firm, inelastic, and almost callous. Occasionally they have an infiltrated, œdematous, or dropsical appearance, serum escaping freely upon the slightest puncture. Their sensibility is usually very feeble, except in very nervous, irritable persons, in whom they are sometimes exquisitely painful, particularly if they are much inflamed. In ulcers from burns the granulations are always distinguished by their excessive tenderness and by the rapidity of their growth.

The discharge furnished by these bodies varies very greatly. When they are in a perfectly normal condition, as indicated by their florid aspect, small size, and steady development, it is usually of a thick, cream-like consistence, and of a pale yellowish color, or, in other words, of the nature of laudable pus; if, on the other hand, they are inflamed and irritable, it will generally be thin and sanious, with an inordinate quantity of earthy salts; when the excitement is very high, the matter is usually mixed with aplastic lymph; hard, callous granulations are often free from all discharge, being apparently incapable of furnishing any matter whatever. In dropsical granulations the fluid is usually serous.

The management of the granulating process must be conducted upon the same general principles as the ulcerative. The leading indication is to favor its development by protecting the raw surface from the atmosphere and whatever else has a tendency to embarrass its progress. The most suitable applications, as a general rule, are water-dressings and emollient poultices, employed in such a manner as, on the one hand, not to excite exuberant action by their warmth, and, on the other, not to repress growth by their refrigerant effect. Rude contact, protracted exposure to the air, and irritating applications must be carefully avoided.

SECT. XI.—CICATRIZATION.

Cicatrization is the completion of the granulating process, the last act in the operation of repair, the hermetic sealing, as it were, of the breach left by the destruction of the tissues of the affected part.

Cicatrization must always necessarily be preceded by a subsidence of the inflammation of the part, just as is the development of granulations, only to a still greater extent. This is an essential preliminary. The granulations having attained the level of the skin, their growth is arrested, and their vessels coalesce so as to form a continuous gelatinous tissue. The next step is a deposit of plasma at the edges of the breach, followed by its rapid organization and conversion into a thin, bluish, or whitish pellicle, abounding in epithelial

scales, and strikingly contrasting, by its peculiar appearance, with the granulations and the adjoining skin. The new substance is always easily detached with the sponge or finger, for as yet its consistence is very slight. Gradually, however, it becomes more thick and firm, assimilating itself more and more closely to the preëxisting integument, whose place it is intended to supply. The process, thus begun, continuing, the plastic, organizable film extends steadily onward until the exposed surface is finally completely covered in, the length of time necessary for this varying according to the size and shape of the breach, the absence or presence of complications, and the state of the system. The majority of the cells of the granulation tissue now disappear by disintegration and absorption, and the gelatinous intercellular substance is converted into fibrillar connective tissue, while the remaining cells assume the characters of connective tissue corpuscles. The superfluous capillaries become obliterated, and the new tissue contracts more and more, until a perfect cicatrice is formed. Ovoidal ulcers or wounds heal, other things being equal, more rapidly than circular, superficial than deep, common than specific. Cicatrization is usually more easily accomplished in the upper extremities than in the inferior, and in the skin and connective tissue than in the other structures. In the organs, properly so called, it generally takes place with difficulty, and only after a long interval.

Cicatrization, as a general principle, always begins at the edges of the breach which it is designed to repair, whence it proceeds towards the centre, which is, consequently, the last to heal. So constant and uniform is this occurrence, that it may be regarded as the great law of cicatrization. It would seem as if the aid of the natural tissues were necessary to enable the new substance to obtain a secure foothold. If, occasionally, an example of an opposite character presents itself, it is simply exceptional, and it cannot, even then, always be determined whether the starting point of the process was not a small fragment of the old structures, which, standing like a little island in the midst of the ulcer, serves as a nucleus to the new. Obviously, in such an event, there is no new law in operation.

Some time necessarily elapses, after the cicatrization is completed, before the new structure, now called a *cicatrice*, acquires much solidity and strength. It is only by degrees that it loses its bluish appearance and assumes the properties of the preëxisting substance. Even then it is at best only a very imperfect copy of the original, whose place it is designed to supply, being destitute alike of hair, sebaceous follicles, and sweat glands. Its vessels, at first remarkably large and tortuous, gradually dwindle down to the size of the natural ones, in the adjacent sound parts, and, when fully developed, generally exhibit a beautiful retiform arrangement, as in fig. 25. The scar always remains tender for some time after its formation, is very liable to break, crack, or ulcerate from the slightest causes, and has a **remarkable tendency to contract or diminish.**

Fig. 25.

Structure of a Cicatrice of the Skin.

What is true of the imperfect reproduction of the skin is equally true of all the textures with the exception of the nerves and muscles in which perfect regeneration both as regards form and function occurs. Of the other tissues new bone comes, perhaps, nearer to the original structure than any other; but even this presents many peculiarities, and it is certain that it often acquires a degree of hardness and solidity far greater than that of the primitive substance. There are, moreover, some pieces of the skeleton which, when broken, unite, not by osseous matter, but by fibrous tissue, fibro-cartilage, or cartilage. Fractures of the patella, the olecranon process, the acromion process of the scapula, and the neck of the thigh-bone within the capsular ligament, are generally, if not invariably, repaired after this fashion, because the ends of the fragments, deprived of their natural supply of blood and nerve-fluid, are unable to pour out the requisite quantity of phosphate and carbonate of lime, to insure their solidification. Cartilage is imperfectly reproduced after injuries; the new substitute is always very thin, hard, and of an unnaturally bluish tint. In fracture of the costal cartilages the consolidation is effected by bone. Tendon is renewed only in the case of subcutaneous section; never when lost by disease. Bloodvessels are never regenerated; their continuity cannot be reëstablished after complete division, on account of the retraction of their extremities. The cerebral, pulmonary, hepatic, splenic, salivary, renal, and seminiferous structures are incapable of reproduction, the new substitute being always of a cellulo-fibrous, fibrous, or fibro-cartilaginous nature. Serous, mucous, and fibrous membranes are repaired in a similar manner. Thus, it will be seen that a tissue, when seriously mutilated, is seldom perfectly reproduced, whatever pains may be taken to assist its efforts.

It is not surprising that a substance so imperfectly organized as a cicatrice should be liable to inflammation and its consequences, as well as to some of the new formations.
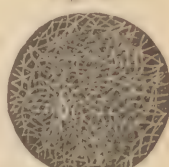
Its powers of resistance being naturally feeble, it generally yields more readily to disease, whether simple or malignant, than the original structures. It is for this reason that inflammation of the substitute-tissue is prone to pass into ulceration, or if the morbid action is at all severe, even into mortification. In suppuration, the matter furnished by the part is nearly always of a thin, ichorous nature, a development of genuine pus being almost impossible under any circumstances.

When a cicatrice is habitually exposed to pressure, it has a great tendency to change into a species of corn, not unlike a corn upon a toe, both in color, shape, and consistence. In other cases, again, it may be transformed into a bunion, burse, or synovial cyst, as upon the extremity of an old stump, especially after amputation of the thigh and leg. A genuine horny growth sometimes occurs upon a cicatrice ; and occasionally the new tissue, from the effects of long-continued pressure, undergoes the cartilaginous, fibro-cartilaginous, or even the osseous degeneration.

A true neuroma is sometimes developed in such a structure, as in a case recently under my charge, in a man, thirty-five years of age, who, twelve months previously, received a lacerated wound in the left middle finger. The parts were long in healing ; and at length an exceedingly hard, ugly scar formed, exquisitely sensitive on the slightest touch, considerably elevated above the surrounding level, and habitually of a red-purplish hue. The tenderness was always worse in cold, damp states of the atmosphere, and, under such circumstances, the pain not unfrequently extended along the forepart of the arm, as high up as the elbow. The principal mass of the growth consisted of an expansion of the digital nerves, incased by dense, fibroid tissue.

The most common form of malignant disease to which cicatricial tissue is liable is epithelial carcinoma ; it may occur upon any part of the body, but is most frequently met with upon the face, hands, and feet, parts which are habitually exposed, or constantly subjected to pressure and friction. The diseased structure, almost of stone-like hardness, and the seat of sharp, pricking, or burning pains, soon ulcerates, and pours out a thin, sanious, and fetid fluid, highly irritating to the neighboring healthy surface. The edges of the sore are hard, steep, everted, or partially undermined, while the bottom is foul and slightly covered with spoiled lymph : occasionally the part has a worm-eaten appearance. The ulcer is always intractable, and, steadily proceeding from bad to worse, is eventually followed by the most serious consequences.

Keloid is another form of disease liable to appear in cicatrices ; this, as will be seen elsewhere, is a peculiar fibroplastic growth, which often forms after burns and scalds, and which derives its name from the supposed resemblance which it bears, in its configuration, to the claws of a crab.

There are certain cicatrices which are habitually dry, painful, and the seat of more or less itching, with a tendency to ulceration and discharge. Old stumps of the leg and thigh, imperfectly covered with integument, with the raw substance firmly adhering to the ends of the bones, are very apt to suffer in this way, and to be a source of perpetual annoyance. Not unfrequently the pain is of a neuralgic character, especially when it is dependent upon the presence of a neuroma, or a bulbous expansion of the nerves. Lastly, the pain, of whatever nature, is often materially influenced and aggravated by hygrometric conditions of the atmosphere, the part and system being conscious of the slightest change of the weather.

Finally, cicatricial tissue sometimes manifests a remarkable disposition to contract, even long after it has apparently attained its full development. This tendency is nowhere more conspicuous than in burns and scalds, where it is occasionally so great as to give rise to the most hideous deformity. Thus, a vicious scar may pinion the arms to the side, retract the hand upon the wrist, and pull down the chin upon the chest. The new tissue, consequent upon the loss of substance caused by salivation, generally contracts in such a manner as to produce firm adhesion of the jaw, sadly interfering with eating, mastication, and even articulation.

In order to prevent the degeneration of a cicatrice, especially if large, it should be protected for a long time from rude manipulation, pressure, friction, and irritating applications. Any tendency to undue contraction should promptly be counteracted, otherwise it may lead to great deformity and impairment of function. A vicious cicatrice may occasionally be advantageously extirpated.

CHAPTER V.

TEXTURAL CHANGES.

UNDER this head may be described those organic changes which are effected in the substance of the organs and tissues, as the result either of inflammation or of defective nutrition, consequent upon lesions in the circulatory and nervous systems. The most important of these alterations of texture are softening, induration, transformations, hypertrophy, atrophy, contraction, and fistule.

SECT. I.—SOFTENING.

Inflammation not unfrequently passes into softening, or what the French pathologists have denominated ramollissement. The event is characterized by a loss of cohesion of the affected textures, varying in degree from the slightest change of the natural consistence to almost complete pulpifaction. All parts of the body are liable to this occurrence, but those which are most apt to suffer are the lungs, brain, spleen, liver, and heart, together with the mucous membrane of the stomach and bowels, the articular cartilages, and the spongy structure of the bones. The subcutaneous and intermuscular connective tissue is occasionally softened to a great extent in rapidly progressive forms of inflammation, particularly in diffuse erysipelas. On the other hand, the vessels, nerves, muscles, and tendons, the fibrous and serous membranes, the lymphatic and salivary glands, the kidneys, the thyroid body, uterus, ovaries, testes, and prostate rarely experience this alteration, however violent the attendant action.

Softening sometimes occurs rapidly, at other times slowly; hence the distinction into acute and chronic. In the former case the affected tissues may be almost completely deprived of their natural consistence within the space of a very few days. Thus, in acute pneumonia the lungs are often so much softened at the end of this time as to be incapable of resisting the slightest pressure of the finger. In the brain and spleen the loss of cohesion sometimes proceeds even more rapidly than in the lungs. Chronic softening is most common in the cerebral substance and in the mucous membrane of the ileum and colon, where it is generally a most insidious disease, often involving a large extent of tissue, and yet unaccompanied by any characteristic symptoms.

The true nature of softening has not been explained. We can, however, hardly divest ourselves of the idea that it is a species of molecular mortification, especially in its more advanced stages. Be this as it may, it is unquestionable that the loss of cohesion, under such circumstances, is entirely incompatible with the exercise of the functions of the part, or its restoration to health. Many of its smaller vessels are completely obliterated, while the remainder are so crippled and paralyzed as to be scarcely able to propel their contents. Changes not less conspicuous are observable in the proper parenchymatous structure, which not only loses its natural consistence, but also its natural color; its cells are infiltrated with serosity, or serosity, lymph, pus, and blood, and its minute texture is no longer distinguishable by the aid of the most powerful microscope. If this is not death, or a condition closely approximating to it, what is it? In the milder forms of mollescence the structure may still retain some vitality, and may, consequently, be able, in time, to regain its original characters; or, what is more probable, may be rebuilt by plastic matter, after the manner of other broken-down and mutilated tissues, the first step in the process being the removal of the effete substance.

There is a species of softening which is intimately connected with, if not actually dependent upon, obliteration of the vessels of the affected structures, with consequent deficiency of blood and impairment of nutrition. It is most frequently met with in the brain and spinal cord of old persons, and is generally supposed, although perhaps erroneously, to be of a non-inflammatory character. If this opinion were correct, it is not probable that we should find, as we always do in this disease, more or less effusion of serum, plasma, and even pus. Wherever these fluids are deposited, they afford indubitable evidence of incited

action; and it would, therefore, be absurd to conclude that they could be poured out here without the agency of inflammation.

This event of inflammation is interesting chiefly in a pathological point of view; for, as it is met with almost exclusively in the internal organs, and presents no characteristic symptoms, it is evident that treatment holds out little prospect of relief. When the true nature of the lesion is suspected, the proper remedies, in the acute form, will be such as are calculated to reduce inflammatory action and to favor the removal of deposits; in the chronic variety a mildly alterative course, with tonics, embracing cod-liver oil, quinine, and iron, is indicated.

SECT. II.—INDURATION.

A deposit of lymph, plasma, or fibrin is common to nearly all inflammations, whatever may be their cause, site, or degree. When occurring upon the free surfaces of the organs, it usually presents itself in the form of a layer, which, escaping the influence of the absorbents, is ultimately converted into an analogous tissue, which often remains during the rest of the individual's life, subject, in the meanwhile, to all the diseases and accidents incident to preëxisting structures. When the deposit takes place in the substance of the organs, it fills up their cells, interstices, or molecular spaces, and thus increases their consistence, as well as their weight, the matter assuming the shape of the cavities in which it is lodged, and being liable, as in the former case, either to be absorbed or to become organized, according to the condition of the part and the vitality of the morbid product. A similar arrangement occurs when plasma is effused into the connective tissue beneath the skin, among the muscles, and in other situations.

Induration is extremely common, and may occur in any organ and tissue of the body. It is most frequently met with, however, in the lungs, spleen, liver, thyroid gland, testicle, lymphatic and prostate glands, mamma, ovaries, uterus, bones, and subcutaneous connective tissue.

Age exerts considerable influence upon the production of induration. In the great majority of the organs it may occur at any period of life, but in some, as in the thyroid gland, for example, it rarely appears before the fourteenth year, while in the genital apparatus it is hardly even observed until after puberty. Induration of the prostate gland, of the vessels, and of the brain and spinal cord is an affection of advanced life, as is also induration of the crystalline lens and its capsule.

The degree of induration varies from the slightest alteration of the natural consistence of the part to the solidity and density of concrete albumen, old cheese, fibro-cartilage, cartilage, or bone. Much, in this respect, will depend upon the nature of the affected tissue, and the date of the lesion, or the degree of change which the deposit upon which the induration depends may have undergone. The color of the affected part may be normal, or variously altered, according to the amount of its vascularity and the presence or absence of effused blood. Much diversity also exists in regard to its volume, although in most cases this is considerably augmented, and sometimes even quite enormously, the bulk many times exceeding that which is natural to the organ in health. The weight of the part, too, is usually increased, and there is commonly some dryness, with a marked loss of elasticity.

The period required for the production of induration ranges from a few hours to several days, weeks, or months, depending upon the nature of the exciting cause and of the affected structures. In the testicle it often occurs in a very marked degree in less than twenty-four hours, and at the end of forty-eight hours the organ may be so hard as to be entirely incompressible. The induration accompanying the development of tonsillitis, adenitis, furuncle, carbuncle, and erysipelas generally occurs with extraordinary rapidity, and the same thing is frequently witnessed in the connective tissue around the joints, especially in inflammation of a gouty or rheumatic character. In pneumonia the parenchymatous substance of the lungs is often extensively solidified within a few days from the commencement of the morbid action. On the other hand, the induration may proceed very slowly, as in goitre, chronic arteritis, hepatitis, and splenitis, and in certain affections of the uterus and prostate gland, where months, if not years, may elapse before it attains its full development.

The effect of induration upon the tissues in which it occurs is of the most prejudicial character, sadly impairing their structure and functions and frequently leading to the worst results. Thus, when it exists in both testicles it may become a cause of impotence; in the liver it may interfere with the secretion of bile; and in the lung it may produce death by offering a mechanical obstruction to the ingress of the air. In the arteries in-

duration is frequently followed by rupture of their coats, leading to aneurism; while in the connective tissue around the joints it always impedes the exercise of the articular surfaces.

The immediate cause of induration is a deposit of plastic matter in the cells of the affected structures, which it thus obliterates while it condenses the adjoining substance, and so renders it unfit, either temporarily or permanently, for the proper exercise of its functions. The fluid is generally associated with more or less serum, and not unfrequently also with pus and even pure blood. When the circumstances under which it is deposited are favorable, it soon becomes organized, and may finally be converted into an analogous tissue, which often retains its parasitic connection during the remainder of life, although in most cases it ultimately disappears.

In the treatment of induration the leading object is to excite the absorbent vessels so as to induce them to remove the deposits upon the presence of which the lesion depends. The sooner this is always done the better. The longer we wait, the greater will be the danger of a permanent change of structure, or, when the organ is one of great importance to life, of the death of the patient. When the deposit is recent, and action still high, our reliance is mainly upon the vigorous employment of antiphlogistics, as bleeding, purging, and diaphoretics, with antimonials, light diet, and rest in the recumbent posture. Inflammation having thus been moderated, the induration, already greatly reduced by the previous measures, may usually be promptly disposed of by alterative doses of mercury, carried, perhaps, to slight ptyalism; and, when the part is accessible, by sorbefacient liniments, embrocations, and unguents, aided by pressure with the bandage. In the more chronic forms of the affection the different preparations of iodine must be brought into play, particularly Lugol's solution, Donovan's liquor, and the various forms of mercury, as the bichloride and biniodide; along with the topical applications just mentioned, if the induration be external. Friction and the cold douche will also prove serviceable under such circumstances.

SECT. III.—TRANSFORMATIONS.

The human body is in a state of constant mutation, decay and renovation, commencing before birth, and continuing down to the last moments of existence. The Wolffian bodies and the gubernaculum of the testicle disappear druring intra-uterine life; then thymus gland is gradually effaced during childhood; the arteries calcify in elderly persons; and at every period of life various states of the system, dependent upon disease or accident, arise, in which there is a strong tendency to the deposition of oil globules, or the transformation of different organs and tissues into fatty matter.

The most important of these changes, surgically considered, are the cellular, mucous, cutaneous, fibrous, calcareous, and fatty; they are all connected with defective vitality, and with atrophy of some, if not all, of the constituent elements of the affected structures.

The *cellular* transformation is met with chiefly in parts that have been rendered useless, either by the natural cessation of their functions, or by accidental circumstances. Thus, the thymus gland, which is evidently connected with some important office in the fœtus, gradually decays during childhood, and is ultimately converted into shreddy cellular substance, of which hardly any trace remains after the thirtieth year. The gubernaculum undergoes a similar change; the gall-bladder, occluded by biliary concretions, is occasionally completely transformed into this tissue; and the cellular adhesions so often seen between the costal and pulmonary pleuræ, consequent upon the degeneration of old, adventitious membranes, are familiar to every pathologist. Various ligaments, especially the capsular, sometimes degenerate in this way, the metamorphosis being most marked in young subjects affected with unreduced dislocations of the hip and shoulder.

When *skin* is inverted for any length of time into one of the natural outlets of the body, as, for instance, the anal, it gradually undergoes a species of metamorphosis into mucous membrane. The first indication of the change is a softened condition of the cuticle and the disappearance of the hair; the epidermis scaling off, the surface beneath assumes a reddish, velvety aspect, becomes extremely vascular, and soon begins to secrete a thin, ropy, whitish fluid, not unlike mucus.

A change from *mucous* membrane to skin is sometimes observed, although the occurrence is uncommon. It is noticed chiefly in prolapse of the rectum, vagina, and uterus, the mucous investment of which, from long exposure to the atmosphere, becomes dry, rough, and insensible, and is ultimately converted into a tissue bearing a more close resemblance to the cutaneous than to the mucous. The transformation, however, as in the case of the skin, is at best extremely imperfect, and it remains to be shown whether, in

either instance, the old structures are so completely deprived of their identity as to justify the idea of a genuine transformation.

The *fibrous* transformation is most commonly met with in those parts of the body that have been deprived, either accidentally or otherwise, of their natural functions. Thus, in an artery that has been tied for the cure of aneurism or the arrest of hemorrhage, the portion of the vessel included between the ligature and the first large collateral branch is gradually converted into a solid cylinder, which, in its turn, is changed into a dense fibrous structure, in which it is impossible to discern any trace whatever of the primitive tissues. Ligaments, serous membrane, and adventitious textures occasionally undergo similar changes. The cornea, in the withered and atrophied eye, the victim of destructive inflammation, is, at times, almost completely transformed into a substance bearing the closest resemblance to the sclerotica, one of the best examples of the fibrous tissue. In some of these cases, as in the one just mentioned, the change is accompanied by a deposit of oil globules. The whitish opaque bodies, so common in the coats of the spleen, in the placenta, and in the arteries of elderly subjects, are apparently essentially composed of fibrous substance, although in their outward characters they strikingly resemble fibro-cartilage.

The *calcareous* degeneration is most common in the arteries, but is also occasionally seen in other parts of the body, as in fibrous tumors, especially those of the uterus, in the articular cartilages, and in the concretions that are sometimes found in the larger joints, particularly that of the knee. In the arteries it generally begins in the form of little opaque patches in the middle tunic, which, as they advance in age, assume a firm, solid consistence, and ultimately convert the vessels into rigid earthy cylinders. The deposit—for such it is, rather than a genuine degeneration—was formerly supposed to be of an osseous character, but that this is not the case is shown both by its chemical and physical properties. In the more matured specimens it is essentially composed of carbonate and phosphate of lime, in union with a minute portion of albumen; in recent cases, on the contrary, the animal matter exists in much greater quantity. It differs still further from bone in having no areolar structure, and in being destitute of vitality. In fibrous tumors of the uterus large calcareous masses, weighing several pounds, are occasionally found.

The *fatty* degeneration, if not the most common of all, is the most universally distributed, since there is hardly any organ or tissue of the body in which, under favorable circumstances, it may not occur. Observation has shown that it may take place even in the lungs, in cartilage, in bone, in the placenta, in the cornea, and in the crystalline lens. It is also met with in plastic exudations, tubercle, morbid growths, and in pus globules. It is of frequent occurrence in the muscles, and in the coats of the arteries, in connection with the atheromatous deposit. In short, it may take place both in natural and in adventitious formations, in the hard as well as in the soft, in the most humble as well as in the most exalted in point of organization and life-power. Of all the various structures, however, which are liable to suffer from it, the liver and the arteries are the most frequently affected. Fatty degeneration may occur in the former at any period of life, even in young children, and is a very common consequence of habitual alcoholic stimulation; in the latter, on the contrary, it is usually restricted to elderly subjects. The senile arc of the cornea is most common in advanced life, and is supposed by some observers, amongst others by Mr. Canton, to be almost always coincident with fatty degeneration of the heart and other organs. Fatty degeneration of the muscles occurs both in the voluntary and involuntary classes, although it is by no means so common in the latter as in the former.

The fat in this degeneration occurs either in the form of a drop of oil or of small granules in the cells of the tissues, their protoplasm being converted by chemical decomposition into fat. Such an infiltration is often observed in the liver, brain, pancreas, and arteries.

An organ that has undergone the fatty degeneration is generally a few shades lighter than in the natural state, diminished rather than increased in consistence, easily torn, greasy to the touch, and of less specific gravity than in health. The amount of oil which it contains often ranges from one-third to one-half of its own weight.

What is the essential cause of the fatty degeneration? In some cases it is evidently connected with a general hypertrophy of the adipose tissue, accompanied by a redundancy of oily matter dependent upon the use of an inordinate quantity of hydrocarbonaceous food and imperfect assimilative power. In the liver of some of the inferior animals the fatty degeneration may often be produced at will, simply by subjecting them to rest, and constantly cramming the stomach with food, which, by creating obstruction in the portal circle, probably induces congestion and inflammation of the hepatic tissues, which thus

favor the deposition of oily matter. The fatty transformation of the liver of drunkards is doubtless occasioned in a similar manner. In other cases the lesion appears to be essentially due to a want of exercise of the affected parts, conjoined with deficient nervous and vascular supply, as is so often witnessed in the muscles of the leg in paralysis of the inferior extremity. Under such circumstances, especially when the case is of long standing, the muscles generally assume a pale, yellowish, or brownish aspect, are remarkably soft and flaccid, and yield a clear oily fluid on pressure, their fibres, however, remaining perfectly distinct.

The treatment of the fatty transformation is unsatisfactory. When the patient's habits are at fault, they must of course be corrected; alcoholic stimulation must be abandoned, the diet must be changed, and a system of exercise must be instituted, to improve the state of the blood and the assimilative powers. Local treatment should not be neglected when the degeneration is suspected to be going on externally, as when the muscles of a limb begin to waste in case of paralysis, disease, or injury.

The *lardaceous* degeneration has been described under various names, as amyloid, waxy, and albuminoid. Its clinical history is still imperfectly understood, although its origin, as is well known, is usually associated with a depraved condition of the system, of which pulmonary phthisis, Bright's disease, syphilis, carcinoma, chronic alcoholism, and affections attended with profuse suppuration, are among the most common and prolific causes. The degeneration is generally widely diffused, but the structures which are more particularly liable to suffer are the liver, spleen, kidneys, lymphatic glands, blood-vessels, muscles, and cartilages. The muscular tissue of the smaller arteries is, apparently, its primary seat. Virchow has seen cases in which the minute arteries of the alimentary canal from the mouth to the anus were literally loaded with amyloid matter. It has also been noticed in false membranes, in recent fibrinous exudations, in tubercle, and in carcinomatous formations of the liver.

An organ affected with the amyloid degeneration is deficient in potassa and phosphoric acid, while it contains an unusual quantity of soda, chlorine, and cholesterine; is increased in volume, consistence, and weight, absolute and specific; feels like a piece of soft wax, or wax and lard combined; and exhibits upon its cut surface a semitransparent appearance, the more delicate sections being perfectly translucent. The coats of the arteries, at first opaque, thickened, and granular, eventually become pellucid, transparent, and hyaline, at the same time that they are diminished in caliber, and so much increased in firmness as to remain patulous when divided.

Lardaceous matter, regarded by some as dealkalized fibrin, has a strong resemblance to albumen, but differs from it in its insolubility in acids containing pepsin. Water, alcohol, and alkalies produce no change in it. The contact of iodine causes a reddish-brown color, characteristic of its nitrogenous nature. The matter seems to pass from the vessels in a fluid state, coagulates firmly in the living structures after it is effused, and is entirely destitute of cell properties. The only form in which it occurs is that of an infiltration, which is often so great as to inundate the tissues in which it is deposited.

The lardaceous degeneration is characterized by a pale waxy appearance of the skin, by anemia, and by progressive emaciation and debility. Its immediate effect is to diminish the lumen of the minute vessels, and thus to interfere with the process of nutrition and repair. Of the immediate cause of the degeneration nothing whatever is known, and of its treatment we are equally ignorant.

The *pigmentary* degeneration occurs principally in the skin, lungs, and lymphatic glands, in certain morbid growths, especially warts and nevoid tumors, and in melanotic carcinoma and sarcoma. The scars of old ulcers of the legs are frequently of a bluish, pink, bronze, or brownish tint, evidently the effect of some abnormal deposit. The lungs in spurious melanosis, as it is termed, so common among colliers, often become remarkably black from the inhalation of carbonaceous matter in an extremely finely pulverized state, and the bronchial lymphatic glands not unfrequently suffer in a similar manner. In Addison's disease of the suprarenal capsules, a bronzed appearance of the skin was at one time regarded as a diagnostic sign of that affection. In melanosis the black color is characteristic of that peculiar formation. Sarcomatous growths are often stained with pigmentary matter; and the so-called analogous tissues occasionally experience similar changes. The pigmentary degeneration is generally denotive of diminished vitality, and no treatment, so far as is at present known, exercises any influence over it.

SECT. IV.—HYPERTROPHY.

The word hypertrophy is employed to designate the increased size and weight which an organ acquires in consequence of an augmentation of its nutrition or of chronic irritation. The hypertrophy may be general or local, and the latter may affect either an entire organ, or be limited to particular portions of it, or even to some of its component elements. It may exist alone or in association with other lesions, and is liable to occur at all periods of life ; sometimes, as in the thymus gland and capillary vessels, apparently even before birth. No organ or structure is probably entirely exempt from it ; but among those which most frequently suffer are the lymphatic glands, mamma, thyroid body, spleen, liver, heart, prostate gland, tonsils, bones, vessels, adipose tissue, and skin. The best example of hypertrophy of the cutaneous textures is elephantiasis, in which the increase of weight and bulk is sometimes enormous.

The causes of hypertrophy are, first, inordinate exercise of the organ ; secondly, mechanical obstruction; and, thirdly, chronic inflammation.

The most simple manner, apparently, in which hypertrophy of an organ occurs is from an increase of its functional activity. Examples of this variety of the affection are found in various textures, particularly the muscles, lungs, and kidneys. The muscles, voluntary and involuntary, are always developed in proportion to the amount of their exercise. Kept at rest, they soon lose their firmness and healthy color, and become comparatively feeble and useless. The blacksmith, who constantly plies his hammer, has much larger and stronger arms than the dancing-master, who merely employs his legs. The same law obtains with regard to the lungs and kidneys. When one of these organs is imperfectly developed, compressed by effused fluid, or destroyed by some morbid growth, the other is sure to become preternaturally expanded, thereby compensating for the deficiency. There are certain viscera, as the uterus and breast, which are subject to temporary hypertrophy. During pregnancy and lactation these organs increase very much in bulk, but again diminish soon after parturition and weaning.

Hypertrophy may be caused, secondly, by some mechanical impediment interfering with the due performance of the functions of an organ. This is frequently seen in the heart, where, from disease of the valves, preventing the easy passage of the blood, the viscus is obliged to perform increased labor, and so becomes more or less enlarged. In the muscular fibres of the stomach, a similar change is often witnessed from obstruction at the pylorus, and in those of the urinary bladder, from stricture of the urethra, or hypertrophy of the prostate gland.

Hypertrophy from chronic irritation is of frequent occurrence, and is met with under a great variety of circumstances. Some of the best examples of this species of hypertrophy are seen in the lymphatic glands of the groin from chronic irritation of the head of the penis, of the mesentery from ulceration of the ileum, and of the bronchiæ from disease of the lungs. Enlargement of the liver and spleen, sometimes of enormous size, is unquestionably due to a similar cause. In chronic dysentery, not only the mucous and submucous connective textures become hypertrophied, but the affection often extends to the muscular tunic, which occasionally attains an extraordinary degree of development. The follicles and villosities, which, in the healthy state, are hardly perceptible to the naked eye, are also rendered extremely prominent, the former being sometimes of the size of a mustard-seed, while the latter are more than a line in length. A similar development is frequently observed in the coats of the urinary bladder, as a consequence of chronic inflammation.

The color of the affected organ is generally much heightened, especially when the hypertrophy is wholly physiological ; on the other hand, it is occasionally greatly diminished, and instances are observed in which it is apparently perfectly natural. The consistence may likewise be normal, diminished, or increased. These three conditions do not, however, occur with equal frequency. An increase of density is by far the most common, and is particularly conspicuous in hypertrophy of the heart, the mammary gland, the muscular fibres of the bladder, the lymphatic glands, connective tissue, bones, liver, spleen, and kidneys. A diminution of consistence is extremely rare, and cannot be viewed as a necessary consequence of the lesion.

An increase of weight of the affected organ follows, as a natural effect, when the lesion is not conjoined with atrophy. An augmentation of volume is by no means constant. Thus, in hypertrophy of the heart and bladder, there may be great development of the muscular fibres, with marked diminution of the size of their cavities. A change of form

always arises when hypertrophy is circumscribed, or limited to a particular point, as in the bones, skin, heart, bronchial tubes, and bloodvessels.

Hypertrophy essentially consists in an augmentation of the nutritive function. Whenever an organ is unusually active for any length of time, a much greater quantity of blood is sent into it than in the natural state, and it assumes a deeper color in consequence, at the same time that its structure is rendered more dense, and its cells multiply and increase in size. It is in this manner that the alteration under consideration is brought about. In that variety of it which results from chronic irritation, it is not unlikely that there is often superadded to the alteration just mentioned a deposit of new substance in the connective tissue, thus leading to an actual change of structure. The effects of hypertrophy on surrounding parts will be considered in connection with the different organs and textures of the body.

In regard to the treatment of hypertrophy, no definite rule can be laid down, as it must be regulated, in great degree, by the nature of the exciting cause, which should, therefore, always be a prominent object of inquiry. Much benefit may generally be anticipated from the steady and persistent use of sorbefacients, locally and constitutionally applied, such as iodine, blisters, compression, mercury, iodide of potassium, and tartar emetic, aided by purgatives and attention to diet. In some cases, nothing short of the removal, partial or complete, of the affected organ holds out any prospect of relief.

SECT. V.—ATROPHY.

Atrophy, the reverse of hypertrophy, consists in a wasting of the substance of an organ, accompanied by a diminution of its weight and bulk. Occurring at all periods of life, it may affect an entire organ, or a part of an organ, or be limited to some of its constituent elements.

Remarkable examples of general atrophy are occasionally met with, but as such an occurrence is of no special surgical interest, it does not demand any particular notice here. Cases of this kind are sometimes apparently of a congenital character; at other times they are the result of disease, and are either curable or otherwise, according to their extent and the nature of their exciting causes.

Local atrophy may be produced by a variety of causes, of which the principal are, first, cessation of the natural function of an organ; secondly, loss of nervous influence; thirdly, deficient supply of blood or nutritive matter; and, lastly, inflammatory irritation.

It is a law of the animal economy that an organ, deprived of its natural functions, gradually falls into a state of decay. Of this class of structure are the umbilical vesicle and the pupillary membrane of the fœtus, the former of which, after having subserved its purpose, disappears at the close of the third month; the latter between the seventh and eighth. The development of the genito-urinary organs is preceded by the formation of two small jelly-like glands, known as the Wolffian bodies, which acquire their greatest bulk about the middle of utero-gestation, after which they gradually shrink, and at length entirely disappear. The gubernaculum, first visible in the tenth week of embryonic life, is a thin, membranous process, which guides the testicle to the internal ring, and is eventually converted into cellular substance. All these are instances of atrophy from the cessation of the functions of an organ in the fœtus. After birth, changes not less remarkable are observed; such, for example, as the wasting of the thyroid body, the suprarenal capsules, and the thymus gland. From the same cause the alveolar processes of the jaws disappear after the removal of the teeth. The ovaries shrink after the decline of the menses; and, in conformity with a similar law, the testicles often diminish remarkably in size in monks, who lead a life of celibacy, in the strict observance of their vows.

Atrophy may, secondly, result from a diminution of nervous influence; a circumstance not surprising when it is recollected how much the action of the capillaries is under the control of the cerebro-spinal axis. Whole limbs sometimes waste from this cause; in other cases the lesion is more limited, and implies only a very partial disorder of the nerves. Atrophy caused by disease of the brain occurs much more slowly than when it is occasioned by an affection of the nerves of the part.

This variety of atrophy is very common in young children during dentition, from the sudden suspension of nervous influence, causing a species of local paralysis, which often terminates in complete wasting of the affected parts. It is most frequently observed in the lower extremities, sometimes in one, at other times in both; but it also occurs in the upper extremities, particularly in the deltoid muscle, which is occasionally transformed into a pale, flabby, membranous layer, hardly a few lines in thickness.

Great atrophy of the upper extremities occasionally occurs from pressure of the head of the humerus, as in dislocations, on the axillary plexus of nerves, thereby interrupting the nervous influx. When such an accident arises in a very young subject, the growth of the limb, if not positively arrested, is imperfectly executed, and not only the muscles, but even the bones, become singularly stunted in their development, their shafts being very thin, and their prominences unnaturally small and indistinct.

A mere perversion of the nervous function of an organ is capable of producing atrophy. In neuralgia of the testicle that organ is sometimes remarkably diminished both in size and consistence, not so much, apparently, from an actual loss of nervous influx, as from a change in its character. What corroborates this view is that the testicle, during the wasting process, is often so exquisitely sensitive as to be intolerant, of the slightest manipulation.

The effects of a deficient supply of blood in producing atrophy are well known. When any part is deprived of the usual quantity of this fluid, it very soon becomes enfeebled, its substance is rendered pale and flabby, and it at last loses its functions, although every other condition for their performance may remain unimpaired. Thus, the testicle wastes after tying the spermatic artery; and, for the same reason, the muscles of the lower extremity occasionally shrink after ligation of the principal vascular trunk of the thigh. Atrophy of the heart is sometimes produced by ossification of the coronary vessels; and a case is recorded in which the spleen, from the obstructed condition of its artery, was not larger than a filbert. In old age, many of the capillaries are obliterated; and it is not improbable to this circumstance is owing that diminution of the size of the organs which constitutes senile atrophy. To the same cause is to be attributed the wasting of the lung and heart, from the accumulation of fluids in the pleural and pericardiac cavities.

Atrophy attendant upon mere want of exercise is probably essentially due to deficient nervous and vascular supply, in conformity with a law, mentioned under the head of hypertrophy, that the development of an organ is usually in proportion to the amount of its use. The wasted and attenuated condition of the legs in club-foot and other affections depriving the muscles of their functions, or interfering with their proper exercise, is probably owing entirely to this cause, as is shown by the fact that, when the disability is removed, the individual gradually recovers the functions of his limbs, the calves often becoming strong and plump, as if there never had been any arrest of growth. The only, or chief, exception to this is where the muscles have undergone the fatty degeneration, when they never regain their original development, but always remain weak and puny.

Atrophy from the effects of inflammation is very common. A good example of this is seen in the wasting which occurs in the gall-bladder from the presence of biliary concretions, in which this organ is sometimes reduced to a mere little fibrous mass, with hardly any trace of the original reservoir. Hepatitis often gives rise to atrophy of the parenchymatous structure of the liver, and orchitis, especially when the result of mumps, is not unfrequently succeeded by impotence. How the lesion, in these and other cases, is produced, is not easily determined. It is probable that the inflammatory deposits may so choke up the capillary vessels of the parts as to deprive them of their customary and necessary supply of nutritive material; or, if this conjecture be untenable, that the pressure exerted by these effusions causes the absorption of some of the anatomical elements of the affected structures, thus reducing them, as it were, to their primitive condition.

Atrophied structures are prone to undergo the fatty transformation, and it is not improbable that this transformation itself occasionally acts as an exciting cause of the wasting process. However this may be, it is certain that the two lesions are sometimes so intimately associated together as to render it impossible to determine which preceded the other, or what part they played as cause and effect.

The change of color experienced by an atrophied organ is necessarily greatly influenced by the natural complexion of the part, but does not possess any special surgical interest. The weight of the affected structures is generally considerably diminished, but their bulk often remains unaltered, and it is not uncommon to meet with cases where it is even greater than natural.

The treatment of atrophy, occurring in an external or accessible part of the body, as a muscle, resolves itself into the use of the warm and cold douche, frictions, either dry or through the medium of stimulating embrocations, shampooing, massage, and the application of electricity, as described under the head of wasting palsy. The general health must be amended, strychnia and tonics being given when there is marked evidence of debility. The affected part must be gradually and steadily exercised, or, as it were, re-

educated : the influences of a strong will frequently directed upon it being often of essential service in rousing its latent faculties.

SECT. VI.—CONTRACTION AND OBLITERATION.

By the word contraction is meant the diminution of a canal, tube, or passage to an extent incompatible with the due performance of its functions. It is strictly synonymous with the term stricture, the signification of which is so well understood by the surgeon. The lesion is liable to occur in various degrees, from the slightest possible change in the size of a canal to the complete obliteration of its caliber.

The chief interest of this subject, surgically considered, relates to the contractions that occur in the mucous canals, or excretory ducts, as they are called, and the bloodvessels, in both of which the lesion is frequently productive of the most disastrous consequences; attended, in the former, by retention of the secretions of these tubes and of the contents of the reservoirs with which they communicate, and in the latter by an impediment to the circulation which, in one case, may lead to atrophy, and, in another, to softening, ulceration, or gangrene.

Contractions of the mucous passages, to which the ensuing remarks are more particularly designed to apply, are deserving of great attention, both from the frequency of their occurrence, and from the great suffering which they so often entail upon those who are the subjects of them. They are met with in nearly every mucous outlet of the body, but are more common in the male urethra and in the nasal canal than anywhere else. Doubtless stricture often exists in the smaller excretory ducts, as those of the prostate and salivary glands, without our knowledge, or without awakening any serious functional disturbance ; in the larger passages, on the contrary, the slightest coarctation is generally a source of more or less annoyance, if not of great pain and inconvenience.

The causes of contraction are mainly two ; inflammation with plastic deposit, and mechanical compression, the former being by far the more common.

The inflammation giving rise to this lesion may be either acute or chronic ; in the former case generally doing its work rapidly, with bold and well-marked symptoms ; in the latter, on the contrary, the injury is often inflicted in a slow and stealthy manner, without perhaps exciting any suspicion as to what is impending. The plastic matter, the real cause of the contraction, is generally deposited in the submucous connective tissue, either exclusively, or partly there and partly in the interstices of the mucous membrane itself. However this may be, it soon becomes organized, and is ultimately transformed into cellulo-fibrous, fibrous, or fibro-cartilaginous tissue, which, gradually contracting upon itself and upon the neighboring structures, thus diminishes, in a proportionate degree, the caliber of the tube in which it is situated. It is in this manner that all organic strictures, properly so termed, of the mucous outlets of the body are formed.

The second cause of contraction is of a purely mechanical character, although in most cases, if not in all, the lesion is attended with inflammation and plastic deposit, secondary, however, in their character. It is thus that stricture of the nasal canal may be produced by the pressure of a tumor in the sinus of the upper jaw ; of the bronchia, by the pressure of an aortic aneurism ; and of the Fallopian tubes, the biliary ducts, and the uterus, by the pressure of an enlarged viscus or a morbid growth in their immediate vicinity. The same cause often induces constriction and even complete obliteration of the bloodvessels. A tumor, compressing the aorta, has been known to give rise to permanent closure of that vessel as effectually as if it had been surrounded by a ligature.

The extent of the contraction varies, both in length and diameter, in such a manner as to render it impossible to specify it in a general manner. In some cases it may not exceed the fraction of a line, while in others it may involve the whole length of the affected tube.

The effects of such a lesion upon the parts concerned are often extremely distressing. Thus, in the urethra, the obstruction is attended with difficulty of micturition ; in the nasal canal, with impediment to the passage of the tears into the nose ; in the œsophagus, with difficulty of deglutition.

The prognosis is, ordinarily, not at all serious, as the obstruction generally admits of relief, except when it has been induced by the compression of some internal tumor of an enlarged viscus, when it will almost necessarily be irremediable.

The treatment of the inflammatory form of contraction must be conducted according to the general principles laid down in the chapter on the exudation of plasma ; by antiphlogistic remedies in the earlier stages of the disease, and afterwards by alterants, rest,

light diet, purgatives, leeches, and a regular, systematic course of dilatation by means of bougies, either alone or aided by incision, scarification, or free division of the affected structures. Great care must be taken, in the employment of dilatation, to conduct it in the most gentle and cautious manner, as the object is to excite the absorbent vessels, and at the same time to keep the capillaries, if possible, in a perfectly passive condition. In this way riddance is eventually effected of the effused matter, upon the presence of which the constriction essentially depends, without the risk of provoking further inflammatory deposits.

SECT. VII.—FISTULES AND SINUSES.

A fistula is a narrow track, straight or tortuous, of variable depth, having generally two distinct orifices, lined by an adventitious membrane, and bathed with a thin, gleety fluid, intermixed with the natural contents of the part, organ, canal, or cavity affected. The disease, which is always of a consecutive nature, occurs in different regions of the body, and is developed under the influence of various causes.

Although the abnormal track has usually two openings, one of which is superficial and the other deep-seated, yet this is by no means constantly the case. Hence the distinction of fistules into complete and partial. The terms recent and old, often used by writers, refer merely to the duration of the disease.

The lesion may occur in almost any situation, but originates most frequently about the anus, perineum, face, groin, and mammary gland. Fistule of the neck, thoracic cavity, the biliary apparatus, the stomach, colon, and small bowel, kidney, pancreas, and urinary bladder, is comparatively rare. It takes place in both sexes and at every period of life; but children and young persons suffer much less frequently than the old and middle-aged.

The nomenclature of fistule is quite extensive. The names are derived either from the parts in which the abnormal passage is situated, as anal, perineal, broncho-pleural, and recto-vaginal, or from the nature of the discharge, as salivary, urinary, and sterco-raceous.

Fistules vary much in their extent. The longest tracks occur along the spinal column in connection with psoas abscess. In this affection, the matter generally escapes at the groin, just above Poupart's ligament, in the upper part of the thigh, or, lastly, in the ileo-lumbar region, the channel which is thus established varying in length from six to twelve inches, and being always lined by a well-organized, adventitious membrane. Passages of considerable length are sometimes met with in the internal organs, as between the kidney and lung, between one coil of intestine and another, or between the urinary bladder and the cutaneous surface. In other situations, on the contrary, the track is remarkably short, being hardly two or three lines from the surface, or from the cavity with which it communicates.

The diameter of these abnormal tracks is also very variable. Sometimes they are so small as scarcely to admit the finest bristle; while at other times they are sufficiently capacious to receive a goose-quill or the end of the finger. The narrowest tracks usually occur in the lachrymal passages, salivary glands, anus, and perineum. It is not often that a fistule is of the same uniform diameter throughout; on the contrary, it is almost always larger at one point than at another.

The external orifice, generally of a rounded or oval shape, may be so narrow, on the one hand, as to be hardly perceptible; or, on the other, so large as to admit the end of a probe, a goose-quill, or a finger. It may have sharp and well-defined margins; be surrounded by a soft, spongy, florid rim; or be depressed, inverted, or infundibuliform. The number of external orifices varies in different cases, from one to as many as six, ten, or even a dozen; when it is very considerable, the affected surface commonly presents a cribriform appearance.

The internal orifice may be of the same size as the external, or it may be smaller or larger. In its shape it is usually irregularly rounded, and it is seldom that it is found multiple, even when the number of external openings is considerable.

Although the direction of the passage may be perfectly straight, yet, in general, it is more or less flexuous, serpentine, oblique, or winding. Occasionally it forms nearly a right angle with the surface upon which it opens. When several tracks exist, they often run together, and terminate, by one common orifice, upon the reservoir with which they communicate.

A fistule, in its recent state, is simply a raw surface bathed with purulent matter. It is, in fact, an ulcer, an open sore, a solution of continuity, which must undergo a pro-

cess of repair before it can justly be entitled to its distinctive appellation. The track, however, soon becomes smooth, and is speedily coated with an adventitious membrane, varying in thickness from a mere film to half a line, a line, or even the sixth of an inch. The new layer, at first soft and easily detached, gradually augments in density, and is at length inseparably united to the parts which it serves to line. Its color, like its consistence, is very much influenced by its age, and by the nature of the secretion or excretion which passes over it. In its earlier stages it is red, pink, or rose; in cases of long standing, white, gray, or slightly bluish. The free surface of the membrane is smooth and polished; or it is rough, mammillated, or studded with villi of various shapes and sizes. The other surface is attached by means of dense connective tissue to the parts upon which it lies. Bands of lymph sometimes extend from one side of the abnormal channel to the other, very much as in the bridle stricture of the urethra.

The membrane here described is formed out of the blood-liquor, and is of the same nature as the pyogenic membrane of a chronic abscess. Around the anus, in the perineum, and in some other regions, it bears no little resemblance to mucous tissue, but differs from it in having no follicles and no distinct epithelial layer. It is liberally supplied with vessels, nerves, and, probably, also with absorbents, is the seat of a constant secretion of gleety or other matter, and is liable, like all new textures, to inflammation and its consequences. In ancient cases it occasionally acquires a dense, fibrous, or fibro-cartilaginous consistence.

The nature of the discharge in this disease varies with the situation of the abnormal passage. In general, it is thin and gleety, as in chronic gonorrhœa, and mingled with the natural secretions or excretions of the reservoir with which the fistule communicates. When, however, the lining membrane labors under inflammatory irritation, the discharge is either entirely suspended, or it is bloody, purulent, or muco-purulent.

The parts in which the abnormal track is situated are variously affected, being sometimes nearly natural, but more generally firm and callous, from the effusion and organization of plasma, which, when present in large quantity, often completely obliterates the meshes of the connective tissue. Owing to this condition, many of the smaller vessels are choked up, while those which remain are, when divided, unable to retract, thus becoming not unfrequently a source of considerable hemorrhage.

The causes of fistules are either mechanical or vital. To the first class belong wounds, contusions, and lacerations; to the second, ulceration, gangrene, and abscesses. There is a variety of the affection which may be regarded as a remnant of embryonic organization. Its most frequent situation is the antero-lateral part of the neck. Like the ordinary fistule, it may terminate in a cul-de-sac, or it may have two orifices, of which the external is sometimes scarcely visible. The abnormal passage itself is usually very narrow, and seldom extends beyond two or three lines in depth.

The treatment of fistule must be regulated by circumstances. In recent cases, before the passage has become lined by an adventitious membrane, a cure will sometimes follow the use of stimulating injections, as a weak solution of nitrate of silver, sulphate of copper, tincture of iodine, or acetate of lead, repeated twice in the twenty-four hours; or by touching the parts lightly once a day, or once every other day, with solid lunar caustic, or with the end of a probe dipped in a solution of acid nitrate of mercury. Strict attention should be paid to cleanliness, and the parts should be maintained in a state of absolute rest. It is seldom, however, that a permanent cure can be effected in this way, especially if the fistule be of any extent, or situated where it is influenced by the contraction of muscular fibres, as, for example, when it involves the anus. The best plan, in fact, nearly always is not to lose any time in vain experiments with these remedies, but at once to lay open the abnormal passage in its entire length, so as to afford the parts an opportunity of healing from the bottom by the granulating process, a tent being interposed between the edges to prevent their readhesion. Occasionally a seton may be passed through the track, and retained until it ulcerates out. In some forms of fistule, as in the vesico-vaginal and urethral, a very delicate operation is generally required in order to effect a cure, consisting in paring the margins of the opening and in bringing them together by the interrupted suture.

The healing of a fistule is often materially retarded, if not effectually prevented, by the presence of foreign matter, as a mass of dead connective tissue, a loose piece of bone, a bullet, or a portion of wadding, or, by the contact of some irritating substance, as urine or feces. The indication, of course, is to remove the extraneous matter, whatever it may be, and then to manage the case upon the principles just laid down.

Occasionally, again, the reparative process may be opposed, at least in part, by deficient tone of the system, or by some disorder of the general health. The patient, for example, may be anemic from organic disease, intemperance, or want of wholesome air and food. Such cases, which are not uncommon in large cities, and in the wards of crowded, ill-ventilated hospitals readily suggest their own treatment.

The practitioner is sometimes sorely perplexed in this disease as to whether he should attempt a radical cure, or limit his efforts to palliative measures. In general, it will be best to let each case be governed by its own rules. When the fistule has been of long standing, and has acted all along as a drain upon the system, serving perhaps to counteract some other affection, such as phthisis or a tendency to apoplexy, no operation should be practised, since it could hardly fail to provoke mischief. In fact, serious organic disease of any kind is a contraindication to an operation. The only exception to this is where the fistule is a cause of excessive local distress, completely depriving the patient of sleep, appetite, and comfort. Under such circumstances, the surgeon could hardly refuse his aid; but, before doing this, he would be sure to open a new source of counter-irritation, in the form of an issue or seton, in some other and more eligible portion of the body, thus establishing a drain at least equal to that which he is about to suppress, as a means of temporary mitigation. In ordinary cases there is of course no reason for delay; the operation is promptly performed, and a rapid recovery is reasonably anticipated.

CHAPTER VI.

CONGENITAL MALFORMATIONS.

CONGENITAL malformations, surgically considered, constitute a subject of the deepest interest, both because they are of frequent occurrence, and because they generally require an extraordinary amount of knowledge and skill for their successful management. Presenting themselves under different forms or characters, they exhibit every variety of grade, from the most simple departure from the normal standard to the most pitiable and disgusting deformity, well calculated to elicit the sympathy and aid of the considerate and humane surgeon. With a view to a more full appreciation of the nature of these malformations, they may conveniently be arranged under the following heads: 1st, deficiency of parts; 2dly, redundancy of parts; 3dly, displacements; 4thly, occlusions; 5thly, deviations of positions; 6thly, adhesions of contiguous surfaces; 7thly, vascular tumors.

1st. The first class, consisting of a *deficiency* of parts, may be subdivided into two orders; the one comprehending fissures, or clefts, and the other an entire absence of certain structures, as a finger, hand, or ear.

The most common, and, in a surgical point of view, the most interesting, fissures are harelip, cleft palate, bifid uvula, exstrophy of the bladder, epispadias, hypospadias, and bifid spine, together with extraordinary patency of the fontanelles. Of these malformations some admit of relief by operation, whereas others are hopelessly irremediable; at all events, every attempt hitherto made to cure them has either signally failed, or eventually destroyed the patient. The operation for harelip is of daily occurrence, and, when properly executed, rarely disappoints expectation; besides, if it fail, it admits of repetition. Staphylorraphy has also become a common procedure, which is frequently, if not generally, crowned with success. Exstrophy of the bladder, consisting in a deficiency of the anterior wall of that viscus and of its protrusion at the linea alba, has hitherto, for the most part, resisted every means directed for its relief. Epispadias and hypospadias are difficult of cure; and a cleft of the vertebra, with protrusion of the envelops of the spinal cord and of the cephalo-spinal liquid is nearly always a fatal affection. The closure of these fissures is effected by paring their edges, and approximating them by suture, ultimate union being accomplished through the intervention of plastic matter. The tumor in bifid spine is emptied with the trocar, and then injected with some slightly stimulating fluid, with the hope of exciting obliterative inflammation. In general, the operation is speedily followed by convulsions, coma, and death.

In the second order of cases the deficiency consists in the absence of certain structures, as a finger, a hand, or even an entire arm. The genital organs suffer perhaps more fre-

quently in this way than any other parts of the body. Thus it is by no means uncommon to find the vagina absent, or the vagina and uterus, or these organs along with the ovaries and Fallopian tubes. Sometimes the testes are wanting, or, if present, they exist only in a rudimentary form, perhaps hardly equalling the volume of an ordinary bean. The penis, too, may be absent; or, instead of being large and well grown, it may, at the age of puberty, be less than that of a child at the eighth or tenth year.

2dly. A congenital *redundancy* of structures is sometimes met with, consisting, chiefly, in hypertrophy of the integuments of various regions of the body, or in the addition of a supernumerary finger, toe, tooth, or ear. To the same category belong the anomalous divisions of certain arteries, as the brachial and femoral, high up in their respective limbs. A redundancy of skin and connective tissue is most common about the neck, hands, feet, and genital organs, as the prepuce and vulva, where the superfluous structures sometimes occur in large, pendulous masses. A supernumerary toe, thumb, or finger is no unusual occurrence; occasionally each hand and each foot are provided with such an appendage. I have seen one well-marked example of four ears. An increase of the natural number of teeth is not uncommon. In some of these cases the supernumerary organ is buried in the alveolar process of the jaw, where I have known it to be productive of such an amount of disease as to require a serious operation for its removal. Most of these malformations admit of cure by retrenchment with the knife, and the operation may generally be safely executed at an early age.

3dly. Congenital *displacements* occur in various parts of the body, but principally in the articulations and in the abdominal viscera. The joints which are most liable to this form of dislocation are the hip, shoulder, and wrist; but it has also, although very seldom, been met with in those of the jaw, clavicle, elbow, and knee. The deformity thus produced is often very great, and what aggravates the case is the circumstance that it rarely admits of relief, however skilfully and perseveringly it may be treated. The malformation, as will be shown elsewhere, probably begins at an early period of fœtal life, and goes on gradually increasing until it attains an irremediable stage.

The most common form of displacement of the abdominal viscera occurs in what is called congenital hernia, caused by a want of closure of the inguinal canal during the descent of the testis. The consequence is that, soon after the child has begun to breathe, the diaphragm, pressing the bowels against the walls of the abdomen, forces them down into the scrotum. The portion of tube thus displaced is generally a loop of small intestine, but now and then other organs are pushed down along with it. The most suitable remedy for such a defect is steady compression upon the neck of the hernia by means of a well-adjusted truss, which generally eventuates in an effusion of lymph, and the obliteration of the sac of the tumor.

4thly. Congenital *occlusion* may occur in any of the mucous outlets of the body, but is much more frequent at the anus and genital organs than anywhere else. Closure, properly so called, of the anus may be produced by a continuation of the integument across from one buttock to the other; or it may depend upon the existence of a fold of mucous membrane situated just within the anus, an arrangement not unlike a hymen. In either case, relief may easily be effected by the knife, patency being afterwards maintained by the frequent insertion of the finger. The prepuce is sometimes completely impervious, or, if an opening be present, it answers very imperfectly the purpose of an outlet for the urine. The vagina is occasionally imperforate, being closed by what is termed the hymen; and there is reason to believe that certain forms of sterility are due to occlusion of the uterus, or of the Fallopian tubes.

5thly. Congenital *deviations* of position are infrequent. The most interesting, in a surgical point of view, is the deformity of the nasal septum, which is occasionally so great as to interfere materially with the functions of the nose, one of the anterior nares being sometimes completely occluded by the projection of the partition towards the corresponding side. A simple operation, consisting in the removal of the incurvated portion of the septum, generally effectually relieves the difficulty.

There is occasionally a remarkable congenital incurvation of the penis, disqualifying the organ for the easy and full discharge of its functions. The defect is always associated with hypospadias, and consequent shortening, or imperfect development, of the spongy structure of the urethra. An admirable operation for the cure of this deformity, devised by Dr. Physick, and successfully performed by Professor Pancoast, myself, and others, will be described in the chapter on the genital organs.

Deviation of position is often associated with permanent contraction or shortening of the muscles and tendons, as is seen in club-foot, wry-neck, and analogous distortions. This

class of lesions is one of great practical interest, having opened to the modern practitioner a wide field for the exercise of his ingenuity and skill, as well as of his patience. Taken in hand soon after birth, they may frequently be promptly remedied by the use of the most simple appliances, whereas under opposite circumstances the treatment will generally be very tedious, even if aided by the free division of the affected structures. The rectification of these malformations forms one of the most interesting chapters in the history of subcutaneous surgery, one of the great inventions of modern times.

6thly. Congenital *adhesions* most commonly occur between the fingers and toes ; more rarely between other parts, as the lids and ball of the eye, the ear, and scalp. The uniting medium is generally merely a fold of common integument, the severance of which often effectually releases the parts from their restraint, and restores them to usefulness.

7thly. There is a class of congenital affections, consisting of peculiar vascular tumors known as *nævi*, or *mothers' marks*, occurring in different regions of the body, especially the head and face, and constituting a very interesting and important form of morbid growths. Their composition is variable ; sometimes they are essentially composed of dilated and tortuous capillary veins, connected by areolar tissue ; at other times they are made up mainly of enlarged and diseased capillary arteries ; lastly, there is a third species which seems to partake of the character of both the others, the two sets of vessels being so intimately blended as to render it impossible to determine which predominates.

These vascular growths, however constituted, almost always begin in the substance of the skin, from which, as they augment in size, they gradually extend to the connective tissue beneath ; they are of a soft, spongy consistence, readily receding under pressure, and expanding under mental emotion. Their color is variable ; the venous varieties being usually of a dark purple, and the arterial of a red scarlet hue. The latter are of a truly erectile character, and hence they commonly pulsate, heaving and throbbing synchronously with the contraction of the left ventricle of the heart. The growth of both varieties is generally steadily progressive, and the consequence is that they often acquire a considerable bulk.

Most of these morbid growths readily admit of cure, especially if timeously begun. This may be effected, 1st, by ligation ; 2dly, by incision ; and, 3dly, by escharotics.

In regard to the causes of these various malformations, it would be out of place to institute any special inquiry into them here. Some of them are doubtless owing to an arrest of development, dependent upon defective organization of the germ ; others are probably occasioned by irritation of the nervous centres ; while others, again, are perhaps due to faulty position of the fœtus in the uterus, or violence inflicted upon it during gestation.

CHAPTER VII.

TUMORS OR MORBID GROWTHS.

SECT. I.—GENERAL OBSERVATIONS.

TUMORS may be arranged under two great classes, neoplasms and cysts. The former, which constitute permanent additions, either circumscribed or diffused, to the natural tissues or organs in which they take their rise, are simply pathological new formations, representing an excess of physiological development and growth under perverted functional or nutritive disturbances. Cysts, on the other hand, may be new formations, although they usually originate in other ways.

Morbid growths are now almost universally classified, for the sake of histological uniformity, according to their likeness to, or derivation from, the physiological tissues. Although this classification has been variously modified by different authors, I have, after careful consideration, adopted the following arrangement, which has, at least, the merit of designating the origin of the neoplasms and the tissues of which they are composed :—

I. Cystic tumors in general.

II. Neoplasms in the strict acceptation of the term.

A. Of these, certain ones are derived from and composed of connective tissue and its equivalents, of which two divisions may be made, namely :—

a. Those which represent perfected or matured connective tissues, and which may,

therefore, be termed typical. These comprise lipoma, or fatty tumor; fibroma, or fibrous tumor; chondroma, or cartilaginous tumor; osteoma, or osseous tumor; and lymphoma, or lymphatic gland-like tumor.

ß. Those which represent embryonic, immature, or unripe connective tissue, and which may be termed atypical, as they do not find their analogues in the adult organism. They are limited to sarcoma and myxoma.

B. The second division of neoplasms includes those which are derived from and are composed of higher tissues. These are, first, myoma, or muscular tumor; secondly, angioma, or a tumor composed of bloodvessels; thirdly, lymphangioma, or a tumor made up of lymphvessels; and, fourthly, neuroma, or a tumor composed of nerve tissue.

C. The third and last division of neoplasms comprise those which proceed from, and are formed essentially of, epithelium. Like the connective tissue growths, they may be separated into those that are typical and those which are atypical.

α. The typical epithelial formations embrace, first, papilloma, or papillary tumor, which has its physiological representative in the papillæ of the cutaneous, mucous, and serous surfaces; and, secondly, adenoma, or glandular tumor, which has its physiological type in the secreting glandular organs.

ß. The atypical epithelial new formations are confined to the genus carcinoma, superficial and deep-seated, with its various divisions.

All neoplastic formations, considered in a general point of view, are governed by two great fundamental laws. The first, originally enunciated by J. Müller, of Berlin, teaches that the constituents of all morbid growths have their types, representatives, or analogues in the normal tissues of the organism, either in their embryonic state, or in a state of complete development. The other, enunciated by Virchow, declares that the cellular elements of all neoplasms have their origin in preëxisting cellular structures. That these doctrines are strictly true, all modern pathologists admit; but it is not true, as Virchow asserts, that the cells of the majority of the neoplastic formations are invariably derived from those of the connective tissue. Carcinomatous tumors, for example, owe their origin to abnormal multiplication and extension of epithelial cells, and, as is well known, wandering cells play an important part in the development of morbid growths.

If these doctrines be accepted, it follows, as a necessary corollary, that all tumors must be in great degree, if not entirely, homologous, and, therefore, that the term heterologous is inapplicable. If, however, the entire structure, and not the individual elements, be regarded as the criterion of heterology, the term should be retained, as there are not a few neoplasms which have no analogues among the normal textures. In point of fact, the so-called homologous growths are for the most part so unlike the physiological tissues that the similarity merely amounts to mimicry. Nothing could deviate more from the normal glandular type than carcinoma, the cells of which extend into the surrounding parts in such a way that the picture is entirely unlike that of the tissue from which it is derived. Through the excessive preponderance and peculiarities of form and grouping of the cells of sarcoma a structure is constituted which is not similar to any matured tissue. Hence the carcinomas and sarcomas must be regarded as heterologous growths. It should, however, be stated that the term heterology is employed by Virchow in an entirely different sense, and that his views have met with general acceptance. He teaches that heterology may be applied to the homologous formations in the sense of misplacement, as a fibroma, for example, in a bone; and he says, " Heterologous structures, when considered in reference to their points of origin, may easily be separated from the homologous ones by their deviating from the type of the part in which they arise. When a fatty tumor is met with in adipose tissue, or a fibrous tumor in connective tissue, the type followed in the formation of the new structure is homologous to the type followed in the formation of the old one. All such new growths are included under the term hyperplasia;" and it is a law that hyperplasia produces a tissue similar to that of the original part. " Heteroplasia engenders histological elements which correspond, indeed, to natural forms, but these elements do not arise in consequence of the proliferation of such as previously existed, but in consequence of a change in the original type of the parent tissue." Thus, chondroma of the testicle or of the parotid gland, and osteoma of the connective tissue, are heterologous tumors, since neither cartilage nor bone are normal to these structures. The original unity of all the tissues emanating from the middle leaflet of the blastoderm explains how tumors derived from the connective tissue can transform themselves one into the other; but in such cases we have to deal with a change in the local histological type, which may be expressed by the term metaplasia. From these statements it follows that the same variety of tumor may be homologous or heterologous. A

chondroma, for example, arising from cartilage is homologous, from bone heterologous; an osteoma of a bone is homologous, but heterologous when met with in the brain. In considering, therefore, the question of the homologous or the heterologous nature of neoplasms, attention is not paid to the " composition of the structure as such, but only to the relations which subsist between it and the parent soil from which it springs." Hence the term heterologous may be applied to a tumour when it differs from the tissue in which it is situated; and the terms homologous and heterologous as formerly employed may be substituted by the terms typical and atypical, which I have already used in the classification of neoplasms. By a typical growth is meant one in which a determined model is followed, so that there is a tumor-like reproduction of apparently normal tissues. In the atypical growths the elements are not arranged upon the physiological type, but they deviate in form, size, and grouping from the normal structures, and represent irregular proliferations.

The development and growth of neoplasms depend essentially upon the proliferation of preëxisting cells and their descendants, either through direct hyperplasia and the primary production of the typical forms of the mother tissue, or after the model of embryonic tissue-formation, and their final conversion into the tissue of which the tumor is composed. Having once started, the tendency of the new growth is to persist and increase, either by central growth, that is, by fresh additions through the progressive multiplication of its own cells, as occurs in the perfected histoid tumors, or by peripheral extension or the formation of fresh foci in the contiguous structures, as is witnessed in carcinoma. In the first mode of increase the neoplasm is circumscribed and frequently encapsuled; in the second it infiltrates and destroys the adjacent tissues.

Although the tendency of most neoplasms is to persist unchanged, they are liable to the same diseases as the normal textures, as is evinced by their inflaming, suppurating, ulcerating, and even dying. They are likewise subject to various degenerations and transformations, as the fatty, caseous, mucoid, colloid, cystoid, pigmentary, telangiectatic, calcareous, and osseous. These changes give rise to certain subdivisions, and are often employed as prefixes to indicate the nature of the transformations or degenerations which have occurred, or designate the existence of certain subordinate tissues.

Neoplasms occasionally change their anatomical character, or are converted into tissues of a different kind. Thus, a simple melanoma, or pigmented nævus, may form the starting point for a sarcoma or a carcinoma; a lipoma may pass into a myxoma, or a myxoma into a lipoma, and a fibroma, particularly of the breast, is frequently transformed into a sarcoma.

A morbid growth may be benign or malignant, that is, it may simply incommode by its situation, weight, or bulk, or it may, after a certain period, as the result of its infectious nature, destroy not only the part in which it appears, but also the patient. The neoplasms which evince malignant attributes are carcinoma, sarcoma, myxoma, and certain kinds of lymphoma.

Occurring at nearly all periods of life, and in nearly all the organs and tissues, the malignant and benign formations possess certain features in common with each other; a circumstance which renders it necessary to study them in a general point of view. Such a proceeding, indeed, is indispensable to a correct appreciation of the structure, diagnosis, and treatment of these affections. The principal points to be considered, in connection with these topics are, first, the physical properties of the morbid growth; secondly, its relations to the surrounding parts; and, thirdly, its history.

1. It would be difficult to point out any *situation* in which tumors may not occur. Glandular carcinoma is most common in the mamma, liver, and mucous follicles. Epithelial carcinoma has a peculiar predilection for the cutaneous and mucous textures at the various outlets of the body. Sarcoma is most frequent in the subcutaneous and intermuscular connective tissue, the periosteum, bones, and the salivary and mammary glands. Benign tumors are usually met with in the skin, connective tissue, ovary, uterus, prostate, and nose. Hydatid formations occur chiefly in the liver, breast, testicle, ovary, and bones.

Tumors affect various *forms*, depending upon the nature and amount of resistance offered to their development, and also, in some degree, upon the shape of the parts wherein they originate. A sebaceous tumor is generally globular; a fatty, either flat or pendulous; a polypoid fibroma or myoma, pyriform, conical, or pedunculated. Malignant growths are commonly distinguished by the irregularity of their surface, which is often lobulated, or marked off into ridges and depressions. Certain tumors occur in the form of excrescences, as the warts on the hands of children, the venereal growths on the penis and vulva, and the so-called cauliflower cancer of the uterus.

In their *volume*, tumors range, in every possible gradation, from a millet seed, as in the little granule on the eyelid, to that of the patient's body, as in ovarian cysts and elephantiasis of the scrotum, those enormous masses which are sometimes absolutely more bulky and heavy than the subject in whom they are developed. Fatty, fibrous, cartilaginous, and osseous tumors occasionally acquire a large size, but they are almost the only ones of their class that do. Among the malignant tumors, those which attain the greatest volume are the encephaloid sarcoma and colloid carcinoma; scirrhous, melanotic, and other formations of this description are usually comparatively small.

Tumors vary in *number*; generally they are solitary, but they may be multiple, depending upon their character and the nature of the organ in which they are developed. Osseous, fatty, and sebaceous tumors occasionally exist in large numbers, whereas most of the other innocent growths are commonly solitary. Sarcomatous and carcinomatous tumors are seldom multiple, except in their secondary forms. Tumors that are multiple from their outset are seldom malignant.

With respect to their *consistence*, some tumors are soft, some solid, some semisolid. Tumors containing serous fluid, as hygromatous cysts of the neck and ovary, are always soft and fluctuating, unless they are overlaid by a large quantity of solid substance, when they may partake of the latter character even more than of the former. Fibrous, cartilaginous, and osseous tumors are known by their great hardness, which equals that of the natural structures. Scirrhus is the most firm of the malignant formations, its name being derived from that circumstance. Occasionally one portion of a tumor is soft, another hard, and a third, perhaps, semiliquid. Ovarian growths exhibit these varieties of consistence more frequently, and in a more perplexing degree, than any other, whether benign or malignant.

The *color* of a tumor is generally a matter of secondary consideration, as the morbid growth is seldom sufficiently exposed to admit of direct inspection, except in some of the mucous outlets. In the early stage of all formations of this kind that take place beneath the external surface of the body, there is usually an absence of discoloration, and it is only when the growth bears too heavily upon the integument, pushing it out and stretching it in every direction, or when it manifests a disposition to ulcerate and evacuate its contents, that it renders the skin red, livid, or purple. In tumors of the nose, mouth, throat, vagina, uterus, and anus, color often affords great assistance in the discrimination of the case. A gelatinoid polyp can never be mistaken for a fibrous one, as its complexion is always diagnostic of its character. It may be assumed, as a law, that the lighter a tumor is externally the greater is the probability of its being benign, and conversely.

Mobility is an important quality in a tumor, its amount varying according to the nature of the affected organ and the degree of resistance offered by the surrounding parts. Some morbid growths are never movable, others always are, whatever their age, volume, or situation. A sebaceous tumor never contracts such firm adhesions that it cannot be pushed about; while an exostosis is always immovable from first to last.

Tumors are endowed with various degrees of *sensibility*, depending upon the peculiarity of their structure and the amount of compression exerted upon them by the parts in which they are developed. Most of them, whether innocent or malignant, are free from pain during their earlier stages; but, as they increase in size, they encroach upon the neighboring tissues in such a manner as to interfere with their movements, and thus seriously compress their nerves, whilst the tissues, in their turn, more or less compress the nerves of the advancing mass. Occasionally the pain is characteristic, as, for example, in scirrhus of the mammary gland. Fatty tumors and cystic tumors of the skin are usually entirely free from pain; or, if pain attend their progress, it is the result purely of accidental circumstances. The subcutaneous tubercle is essentially a painful growth from first to last; occasionally the suffering is of a neuralgic character, and extremely distressing by its constancy and severity.

2dly. In regard to the *relations* which tumors bear to the surrounding structures, several circumstances deserve to be noticed. The first is the manner in which they are bound down, or inclosed in their habitation. Every tumor must necessarily have an appropriate residence, but like a settler in a new country, it is seldom content with the spot originally assigned to it. On the contrary, soon lacking room, it encroaches upon, frets, and worries the parts around it, which are not slow to resent the invasion. Mutual oppression and discomfort must be the necessary result of such invasion. For a while the healthy structures successfully resist the intrusion, but as they yield, the enlarging mass often converts the muscles into mere ribbons and the bones into mere shells.

Function, too, may be seriously interfered with; the ranula filling the mouth, the goitre compressing the neck, the myoma occluding the womb.

In the second place, the tumor, as it progresses, is liable, either by its continued pressure upon the overlying parts, or by the gradual decay of its own structures, to produce ulceration, followed by more or less discharge. This tendency, although most conspicuous in the malignant formations, is also witnessed in some of the benign, as the encysted and adipose. Large vessels are sometimes laid open during the progress of the affection, thereby inducing copious hemorrhage.

Tumors often occasion serious disease in the surrounding lymphatic glands. This is particularly true of carcinomatous tumors, in some of which it forms a very conspicuous, if not an unmistakable, feature. Thus, in carcinoma of the tongue, breast and testicle, especially when the disease is fully developed, there is always marked enlargement of the glands, respectively, of the neck, axilla, and groin, either from actual invasion by epithelial cells, or from the effects of sympathetic irritation.

Finally, an intimate *sympathy* exists between tumors and the constitution, operating at one time beneficially, at another prejudicially. The progress of malignant growths is frequently stayed for months and even years, simply by attention to the general health; on the other hand, it is often astonishingly hastened by disorder of the system, and, in fact, by whatever has a tendency to produce derangement of the secretions, especially those of the liver, uterus, and kidneys.

3dly. The *history* of the case often furnishes important points of comparison. Tumors occur at all periods of life, in all classes of persons, and in all varieties of temperament. Certain forms of malignant disease, however, are most common at one period, and others at another. Thus, carcinoma is almost peculiar to elderly subjects, while sarcoma is most frequent between the ages of twenty and forty. The lymphomatous tumor is most common in childhood and adolescence. Benign growths of every description are often observed in early life, some, indeed, being even congenital; but the greatest number by far occur in young adults.

The distinction between innocent and malignant tumors, and between different tumors of the same class, is often extremely difficult, and occasionally, for a time at least, impracticable. For this reason great care and patience are frequently required in order to prevent mistake. Rapidity of growth, great bulk, increase of temperature, a pulpy consistence, firm and extensive adhesions, and early lymphatic involvement, imply inordinate vascularity, and lead to a suspicion of malignancy. There is no tumor, except, perhaps, the round-celled sarcoma, that acquires so large a bulk in so short a time as the encephaloid carcinoma, and there is certainly none that is more surely fatal. Ovarian cysts, of the non-malignant type, often grow very rapidly, and are capable of attaining an enormous size. Sebaceous, fatty, and osseous tumors, on the contrary, usually advance slowly, and occasionally enjoy even a considerable period of repose or inactivity.

Tumors situated immediately over or around an artery generally receive a distinct impulse from the shock imparted to them by the blood. Such tumors, which are very liable to be mistaken for aneurisms, are called pulsating tumors, and are most common in the neck, abdomen, groin, and ham.

The phantom tumor, as it is termed, is only met with in the abdomen, chiefly in nervous, hysterical women, although it is not peculiar to the female sex; and depends, in most cases, partly upon the contraction of the muscles and upon a fat, plump state of the belly, but mainly, and often almost exclusively, upon an accumulation of gas and feces in some particular portion of the bowel, especially the large. The best and surest diagnostic of such a tumor is chloroform, under the relaxing influence of which it always speedily vanishes, the muscles becoming soft and flaccid, and the spine distinctly traceable underneath.

The structures immediately around morbid growths, especially the malignant, and the larger and more rapidly developing innocent, are habitually congested; and hence such tumors are usually a source of great pain and inconvenience. For the same reason operations undertaken for their removal are often unavoidably attended with copious hemorrhage.

It is not often that a tumor disappears spontaneously, although such an occurrence is not impossible; and there are several ways in which it may be effected, as by absorption, enucleation, ulceration, and gangrene. The first of these modes of cure is the most common; and one of the best examples of it is witnessed in the lymphomatous tumor, so frequent in the neck and about the angle of the jaw in strumous children, from exposure to cold and derangement of the digestive organs. The disease essentially consists in an inflam-

matory enlargement of one or more lymphatic glands, which, after having perhaps existed for years, finally disappear without any assignable cause, merely, as it would seem, in consequence of an improved state of the general health, and of a change in the nutrition of the part.

Sometimes a tumor is enucleated, and drops off, leaving perhaps merely its inclosing cyst. It is thus that the fibrous tumor of the uterus is occasionally detached; and a similar accident may happen to an exostosis, particularly if it be large and situated upon the skull. In such cases the vascular connection between the morbid growth and the circumjacent structures is probably, as a preliminary step, in great degree, destroyed, so that the tumor, gradually dying and acting as a foreign body, is at length cast off by the living tissues.

A cure is occasionally effected by profuse suppuration, or, more correctly speaking, by suppuration and ulceration. The kind of tumor most easily influenced in this way is the lymphomatous, which is completely disintegrated and broken down, or it is dissected off by ulcerative action, and is finally detached as an effete substance.

Lastly, gangrene seizing upon a tumor, may so interfere with its circulation as effectually to destroy its vitality. Such an occurrence, although very rare, may take place in a malignant as well as in a benign growth. An elderly lady, a patient of mine, had scirrhus of the mammary gland, which, after having gone on for upwards of a year, was suddenly attacked by gangrene, and in less than a week it dropped off in the form of a black slough, leaving in its stead a large excavated cavity.

It is still a mooted question whether there is a class of tumors intermediate between those so frequently referred to above, to which, scientifically considered, the term semi-malignant is properly applicable. I am not myself inclined to accept such a division; for the reason that, while it is difficult, if not impracticable, in many cases, clearly to define the boundaries between innocent and malignant formations, it is impossible to form any conception of such an occurrence. A tumor must be one thing or another, either innocent or malignant; it cannot be semiinnocent or semimalignant, although, as it respects portions of the same growth, one may be of this structure and another of that, as is occasionally witnessed in what is termed a combination tumor. A tumor may apparently be innocent so far as its autological phenomena are concerned, and yet be found, upon microscopic examination, to be malignant. A sarcoma is often as malignant as the worst form of carcinoma; and it must not be forgotten that a tumor originally benign may, in the course of time, assume the most destructive type.

Certain tumors, as, for example, the fatty, are composed chiefly, if not wholly, of a single tissue, and are hence designated as histoid. When the number of structures is greater, the term organoid is employed; while teratoid is the expression used when the formation is unusually complex, as when it represents the highest type of organization and development. The combination tumor, consisting of a union of several morbid growths, ingrafted, as it were, upon one another, is sufficiently common. Formations of an entirely different character, as the nævoid, cystic, fatty, fibrous, calcareous, and osseous, are thus occasionally associated in the same morbid mass, especially in the old, retrogressive forms.

The distinction between acute and chronic tumors is well founded. Most of the so-called innocent tumors are characterized by slowness of growth; now and then, however, a case is met with in which the development is very rapid, the morbid mass acquiring, perhaps in the course of a few months, a very extraordinary weight and bulk. To such a growth the term acute is applied, in contradistinction to the more ordinary chronic forms. Malignant tumors, as the different varieties of carcinoma and the worst types of sarcoma, generally possess a remarkable proliferating power, often advancing with frightful celerity.

The *etiology* of tumors is not well understood. That inflammation is frequently concerned in their production is unquestionable, a view which I have long entertained, and which is also held by Virchow, Samuel, Wagner, Birch-Hirschfeld, Cornil and Ranvier, Woodward, Formad, and others. In many cases, indeed, both of innocent and malignant tumors, their origin is directly traceable to the effects of injury, as a bruise or contusion. Keloid tumors often supervene upon burns, scalds, and other lesions; epithelial growths are very common at those parts of the skin and mucous membranes which are habitually exposed to irritation; and the influence of long-continued pressure in producing carcinoma is well exemplified in the undescended testicle compressed by the walls of the abdomen. In the great majority of cases, however, tumors of every descrip-

tion arise without any assignable cause. Examples of hereditary neoplastic formations are uncommon.

All forms of tumors occasionally manifest a disposition to return after extirpation, the secondary growths constituting what are called *recurrent tumors*. This tendency is not, as was formerly supposed, by any means peculiar to malignant growths, as the different varieties of carcinoma and sarcoma ; innocent tumors also occasionally exhibit it. With respect, however, to the latter, there is good reason to believe that recurrence is generally due to imperfect removal. Every surgeon has witnessed examples of recurrence after the excision of an ordinary sebaceous tumor of the face and scalp. The smallest fragment that is left behind in such a case must necessarily serve as the nucleus of a new growth, which may eventually attain the same bulk as the original. Proliferous cysts, chondromas, nævoid angeiomas, and myxomas, all, at times, manifest this disposition. In none of the morbid growths, however, is it so frequent, or so conspicuous, as in carcinoma and sarcoma, in the former of which it is always malignant, with a certainty of the early destruction of the patient, whereas, in the latter, the tumor may recur again and again, perhaps as often as three, five, or even six times, at intervals of several years, and death at last be produced by some other disease.

The recurrent growth may, in structure, be essentially like its predecessor, or it may exhibit typical variations ; not, however, so striking as to constitute material departures. The likeness to the parent still exists, at all events in certain parts, even when the new tumor assumes the character of malignancy. The new growth may appear at the site of the primary one, as, indeed, it most generally does, the cicatricial tissues seemingly serving as the starting-point. Not unfrequently, as in carcinoma, it selects the lymphatic glands. Occasionally an internal organ is involved, entirely unlike the original both in structure and function. Properly speaking, however, this is not a recurrence, consequent upon the removal of the primitive growth, for the same causes that may produce a tumor in one organ may produce a similar tumor in another, either simultaneously or consecutively. In strictness of language, the term recurrent should be limited to the new growth that occurs at the seat of the parent one. All other formations should be regarded as coincident or accidental, uninfluenced, so far as their exciting causes are concerned, by the one removed.

The secondary formations so often witnessed in the lymphatic glands, and in some of the internal organs, as the lung and liver, after the removal of carcinomatous and sarcomatous tumors, have their origin in cells that are detached from the original growth, and that wander about, as it were, in search of new homes, their transmission being effected by the lymphatic vessels, and probably, also, at least in many cases, by the veins. Such formations are now generally known by the somewhat equivocal name of metastatic tumors, and the state of the system, under the influence of which they are developed or generalized, as the infectious dyscrasia.

When a tumor that is originally innocent assumes a malignant character, the occurrence usually manifests itself by a rapid increase of bulk, by more or less serious encroachment upon the adjacent structures, especially the lymphatic glands, by a tendency to ulceration, by an impoverished condition of the blood, and by a constitutional dyscrasia, which becomes more and more conspicuous as the disease progresses.

Death from tumors may be occasioned by sheer malignancy, by the injurious effects exerted by the morbid growth upon important structures in its neighborhood, by secondary formations, by profuse hemorrhage, and by various other causes, as excessive suppuration, hectic irritation, pyemia, and erysipelas.

SECT. II.—CYSTS AND CYSTOMAS.

Cysts are sacs filled with more or less fluid contents. They may be classified in accordance with their mode of development, first, as retention cysts, or those which arise from the retention and accumulation of the normal secretion of glands ; secondly, as exudation cysts, or those which result from the distension of closed cavities ; thirdly, as dermoid cysts, or those which arise from fœtal inclusions ; fourthly, as cystomas, properly so called, or cysts of new formation, which are possibly due to cystic degeneration of the cells of the connective tissue ; fifthly, as extravasation cysts, or those which form around effused blood ; and sixthly, as hydatid cysts. It will be seen that I have excluded from this nomenclature the so-called softening cysts, which represent the fatty, mucous, and colloid degenerations of the tissues of the various neoplasms, thereby constituting the cystoid neoplasms. The proliferous cysts are also discarded, since, as for example, in the

mammary gland, they are merely solid projections of variously shaped masses into the deformed and enlarged ducts from the tissues which compose the original growth. As they are secondary changes, the neoplasms in which they are found are distinguished by the prefix cystic.

The cystic formations are not only of very frequent occurrence, but they are capable of acquiring an extraordinary bulk. Their contents, which are of a singularly diversified character, may be either solid, semisolid, or liquid. Occurring in nearly every organ and tissue of the body, they are particularly liable to arise in the skin and mucous membranes, the glandular organs, as the breast, testicle, liver, and the ovaries, and in the subcutaneous connective tissue. While no period of life is exempt from them, they are most common between the ages of twenty and forty-five, especially in females, who are also more subject to them than males, and in whom they frequently attain an enormous volume. Occasionally they have an intra-uterine origin, and in many cases they arise soon after birth.

1. RETENTION CYSTS.—Retention cysts consist merely of a thin cyst, sac, or bag, occupied by the natural secretion of the affected part, more or less altered by its protracted retention. An excellent type of this variety of morbid product is afforded by the so-called sebaceous tumor, which, in reality, is nothing more than a sebaceous follicle of the skin, in a state of hypertrophy from the occlusion of its orifice, and the consequent retention of the sebaceous matter. The immediate cause of the obstruction is inflammation, causing obliteration of the outlet of the follicle, and thus constituting the first link in the chain of morbid action. The second is the retention of the normal secretion of the follicle, which, being tightly pent up, undergoes important changes, both in its physical and chemical properties, leading to irritation, and sometimes even to inflammation of the sac, which, gradually enlarging before the accumulating and burdensome mass, at length forms a tumor perhaps as large as a medium-sized orange. The cystic tumor that is sometimes found upon the lower lip and upon the vulva arises in a similar manner. Ranula owes its origin to a like cause. Obstruction of a lactiferous duct may give rise to the cystic milk tumor of the breast. In the cysts which occur in the liver and kidney, the mode of formation is extremely simple, the hepatic and renal ducts being at first constricted, and finally, in many cases, obliterated by interstitial inflammation.

The contents of retention cysts must necessarily vary, as may be gathered from what precedes, according to the structure and functions of the affected part. Thus, in the mamma it contains milk, in the ranula saliva, and in a sebaceous formation sebaceous matter; altered, in every instance, in its physical and chemical properties. The cyst itself may be either solitary or multiple, and is generally composed of a single layer of connective tissue, its external surface, which is rough and flocculent, being more or less firmly adherent to the surrounding tissues, while the internal one, lined by epithelium, is usually smooth, shining, or glossy, without septa, and in immediate but loose contact with the proper contents of the tumor. It varies in thickness from the merest film up to that of a stratum several lines in depth. In cases of long standing it is occasionally partially converted into a substance resembling fibro-cartilage, cartilage, bone, or earthy matter.

Retention cysts are most appropriately described according to the nature of their contents, as serous, mucous, salivary, oily, milky, seminal, and sebaceous.

a. Serous cysts, the most common of all, are met with in all situations and at all periods of life, in their most simple as well as in their most complex form. Many of them are congenital, especially the more simple varieties, and not a few make their appearance soon after birth. Their most common seat is in the mammary gland, the liver, the kidney, the ovary, and the testicle.

The contents of these cysts are, as their name implies, generally of a thin, watery character, slightly saline in taste, and coagulable, in whole or in part, by heat and acids, thus showing that they are composed largely of albuminous material. The color is not always uniform. In the smaller and younger cysts the fluid is usually transparent, or clear and limpid, like well water; under opposite circumstances, on the contrary, it is often quite turbid, muddy, greenish, milky, or sanguinolent. In protracted jaundice I have occasionally found it to be of a pale lemon tint, evidently caused by the presence of bile; and in suppuration, to which, in certain situations, the cyst is very prone, the fluid is always intermixed with pus and lymph. The contents of certain serous cysts sometimes coagulate spontaneously on exposure to the air. Their walls are commonly thin, and originally translucent, if not actually transparent; but as they grow older they increase in thickness and density, and present an opaque appearance. Connective tissue, lined by

pavement epithelium, forms the essential basis of their structure, which, in cases of long standing, is often partially transformed into fibroid substance, with, here and there, perhaps, a minute calcified patch.

β. *Mucous cysts* occur chiefly in connection with the glands of the mucous membranes, those more particularly of the lips, the cheeks, the vulva, the vagina, and the uterus. Mucous cysts are occasionally developed in the maxillary sinus, in different portions of the alimentary canal, and in the glands situated in the posterior wall of the trachea, forming small projections between that tube and the œsophagus. They have also been observed in the larynx and upon the epiglottis.

The contents of mucous cysts are nearly always of a thick, ropy, glutinous consistence, intermixed with epithelial matter, and numerous corpuscles closely resembling white blood corpuscles. In the more recent cases the contents are thin and clear, like normal mucus or the white of an egg. Occasionally they bear a strong resemblance to the fluid of a synovial bursa; Paget has seen it of the color of the ink of the cuttle-fish; and in some cases, as those observed by Hawkins and Lebert, it has the aspect and consistence of thin fecal matter.

The cyst-wall is generally thin and composed of a single layer, smooth internally, lined by epithelium, and intimately adherent to the parts around by dense connective tissue. In shape, such tumors are usually spherical or pyriform, and in volume they range from a pea to a large fist or even a fœtal head, as is occasionally seen in the vulva and the vagina. Old mucous cysts of the genital organs are prone to inflammation and suppuration.

γ. *Salivary cysts* are peculiar to the salivary glands, being most frequent in the sublingual gland, constituting there what is known, surgically speaking, as ranula. A tumor of this kind, of considerable size, occasionally forms in the duct of Steno, from the occlusion of its orifice. The contents of these cysts are thick and ropy, like the white of egg, and consist essentially of saliva, mixed with a large quantity of mucous and epithelial matter.

δ. Cysts containing *milk*, sometimes of considerable bulk, are liable to form in the mammary gland during the process of lactation. At least half a dozen such cases have fallen under my observation, mostly in young females, within the first six or eight months after parturition. Obstruction of one or more of the lacteal ducts, from inflammatory deposits or inspissated milk, is the immediate cause of the formation. The size of the cyst is variable. In a case recorded by Scarpa, it was enormous, the contents amounting to upwards of one gallon. The fluid may be pure and perfectly liquid, or it may be combined with caseous and epithelial matter.

ε. *Oil cysts* are uncommon. They are usually quite small, and are generally due to advanced fatty degeneration of the epithelium of sebaceous cysts and of milk globules. Hence they are generally seated in the skin and breast. In one case, that of a young woman, I met with a cyst of this kind in the mammary gland partially filled with oil and a material strongly resembling curds, the result evidently of altered and disintegrated milk. The oil, on exposure to the air, sometimes congeals into a substance not unlike lard, containing acicular crystals of palmitine and stearine.

ζ. *Seminal cysts* are frequently confounded with hydrocele of the cord. The fluid from which they derive their name is chiefly composed of turbid serum, holding the characteristic spermatozoa, which can only be distinguished by the aid of the microscope, as it were, in suspension. Such bodies are occasionally contained in the fluid of ordinary hydroceles, but the only true spermatoceles, or seminal cysts, originate in dilatation of the seminal tubes in the vicinity of the head of the epididymis.

η. *Sebaceous cysts* comprise milium and comedones, which arise in the hair-follicles and contain epidermis; and steatoma or atheroma, which consists of an accumulation of sebum and epidermis in a sebaceous gland. As these formations are fully discussed among the tumors of the skin, their further consideration here need not detain us. A substance of a whitish pearly aspect is sometimes found in these cysts, described by some authors under the name of pearly tumor or cholesteatoma. The contents consist essentially of a white, dry, fatty substance, composed partly of epithelial cells and partly of cholesterine and palmitine and stearine, the whole being inclosed in a cyst of variable size and form. The growth, hitherto observed chiefly in the temporal bone, cerebellum, testicle, and ovary, is very uncommon.

II. *Exudation Cysts.*—Cysts which result from the accumulation of the contents of preëxisting closed cavities or cavities which are not provided with an excretory duct are known as exudation cysts. Among the most characteristic types of these formations are the *synovial cysts*, ordinarily known as ganglions and bursæ, which are so common in the

synovial sheaths of the tendons of the wrist and on the front of the patella, the latter constituting the so-called housemaid's knee. In the sheaths of the tendons and the natural burses the abnormal development is caused by the transformation of the cells inclosed in the fringe-like processes of the synovial membrane.

The volume of these cysts is generally small, and in their form they are, for the most part, rounded, globular, or hemispherical. In the sheaths of the tendons cysts of this kind have occasionally a tuberculated, knobby, or constricted appearance, as if they were divided, as, indeed, they not unfrequently are, into several compartments. The structure of the cyst-wall varies from simple connective tissue to fibroid, or even fibro-cartilaginous tissue, age and pressure being the principal modifying circumstances. Their contents may be serous, mucous, glutinous, colloid, or of jelly-like consistence, and of a whitish-opaque appearance. The so-called ganglionic cysts of the sheaths of the tendons, especially those of the wrist, often contain great numbers of small, free bodies, resembling cucumber seeds in shape, composed of compact connective tissue, and developed evidently under the influence of long-continued pressure and friction. Bursal cysts are very prone to inflame and suppurate; their walls are often very thick, and their inner surface occasionally exhibits a peculiar retiform appearance, the effect of inflammatory deposits.

III. *Dermoid Cysts.*—Cutaneous or dermoid cysts differ from sebaceous cysts in not being originally provided with an excretory duct, and in the composition of their walls, which contain all the elements of the cutis. They are always congenital, and are usually seated in the connective tissue around the orbit, root of the nose, floor of the mouth, near the angle of the jaw, along the sheath of the carotid vessels, in the vicinity of the anus, and in the sacrococcygeal region. In these situations, as well as in the anterior fontanelle, they evidently arise from the imperfect closure of the branchial clefts, and the clefts along the median line. Their contents are commonly composed of sebaceous matter and short, white hairs. In the ovary, the testicle, the brain and its meninges, the eye, the anterior mediastinum, the thymus, the lungs, the mesentery, and the omentum, in which they are also found, dermoid cysts may also contain teeth and rudimentary cartilage and bone, showing that they are probably the remains of fœtal inclusions.

IV. *Cystomas.*—Cysts of new formation, lined by endothelium, and containing serous contents, are of frequent occurrence, as is witnessed in the so-called congenital cystic hygroma of the neck, perineum, and axilla. Their mode of development is a matter of conjecture, but it is probable that they arise from cystic degeneration of the corpuscles of the connective tissue. A good example of the neoplastic cyst is the accidental burse which is developed under the influence of protracted pressure.

V. *Extravasation Cysts.*—Cysts occasionally form around extravasated blood, constituting what are known as hematomas or as sanguineous cysts. They have their seat most commonly in the neck, groin, and trunk. Their contents consist either of pure blood or of blood mingled with serum and other substances. The cyst-wall is usually very thin and smooth, but in some cases the inner surface has a peculiar fasciculated appearance, not unlike that of the right auricle of the heart. The cyst is commonly small, of a rounded or hemispherical shape, and fluctuates on pressure, especially in its earlier stages.

VI. *Hydatid Cysts.*—The hydatid cyst differs from the ordinary cyst in one essential particular, that is, it contains an entozoon, parasite, or vesicular worm, inclosed in a distinct, separate sac, originally described by Laennec under the name of acephalocyst, a term signifying headless bladder. The organs in which it is most commonly found are the liver, ovary, and uterus. It is also met with, although much less frequently, in the mamma, brain, testicle, kidneys, lungs, bones, serous cavities, and subcutaneous connective tissue. In my cabinet is a beautiful specimen of hydatid tumor which I removed from the deltoid muscle of a young man, a patient at the College Clinic.

Varying in volume between a mustard seed and a small orange, the entozoon is of a globular figure, of a whitish, semiopaque appearance, and composed of a vesicle, or bladder, filled with serous fluid, and surrounded by a fibrous capsule, which thus isolates and protects it from the circumjacent structures. It is usually gregarious, numbers of them inhabiting a common cyst, as in fig. 26; sometimes, however, there is only a solitary one, which is then commonly proportionately large. The contents of the animal are of a clear limpid character, remarkably saline to the taste, but destitute of odor and coagulability. The inclosing cyst is fibrous, more or less vascular, and possessed of considerable strength. Between this cyst and the parasite there is commonly a soft, pulpy, dirty-looking substance, the precise nature of which is undetermined. Owing to its endogenous

mode of generation, a large hydatid sometimes contains several smaller, one within another, like so many pill-boxes.

Although the hydatid itself consists of two distinct layers, it is generally so weak and delicate as to break under its own weight when removed from its inclosing cyst, shrinking into a soft, pulpy mass, not unlike the white of a hard-boiled egg, both in appearance and chemical composition. The inner surface of the parasite is studded with numerous little bodies, seen in fig. 27, resembling diminutive fish-spawn, hardly as large as a grain of sand, of a spherical shape, and of a grayish color, each consisting of a delicate cyst, filled with echinococci. The echinococci, deriving their origin and support from the hydatid, soon lose their connection, and thus acquire an independent existence, great numbers being often seen floating about in the parent liquor when they are yet hardly the two-hundreth part of an inch in diameter.

Fig. 26.

Hydatids inclosed in a common Cyst.

Each echinococcus consists of a body and a head, the latter being encircled by a row of teeth naturally concealed in a narrow cleft, but capable of projecting itself. The body, composed of solid, granular matter, has a curiously speckled appearance, due to the presence of numerous ovoid spots immediately beneath its outer coat. The teeth, or hooklets, are spinous, sharp, and perfectly characteristic. They are not easily decomposed, and are, therefore, capable of affording important diagnostic information. The various appearances here described are well illustrated in fig. 28.

Fig. 27.   Fig. 28.

Cysts of Echinococci.   Echinococci.

Hydatids are much less common in this country than in England and the continent of Europe. Nowhere, however, are they so prevalent as in Iceland, where, according to Eschricht, a sixth part of the population is infested with them. Men are more subject to them than women; and it is obvious that the ova of the parasite, derived for the most part from the dog, are introduced into the stomach with the food, from which they afterwards find their way into the different tissues and organs of the body. In one district, where the disease is most common, and where the inhabitants are accustomed to eat raw, smoked mutton, Dr. Hjaltelin reports that nearly every adult sheep and every third person are affected with the disease.

Hydatids are usually short-lived, rarely lasting beyond a few years. Various causes may destroy them, as suppuration, gangrene, the gradual desiccation of their contents, and the pressure of their young. Under such circumstances, the inclosing cyst is often remarkably thickened, and even partially transformed into fibrous, fibro-cartilaginous, or calcareous matter. I have seen instances where it had assumed an appearance similar to the interior of an aneurismal sac. Great mischief eventually arises from their presence, especially during their decay, from the violent irritation which they excite. A hydatid of the liver occasionally induces fatal peritonitis; and the hardest structures, the osseous not excepted, are not always capable of withstanding its progress. In one case a parasite of this kind perforated the scapula. In the lungs acephalocysts sometimes find their way

into the bronchial tubes, from which they are afterwards ejected by expectoration. In the kidneys they are commonly voided with the urine, either whole or piecemeal.

Under the term "multilocular echinococcus tumor," or "alveolar hydatid tumor," Virchow, Carrière, and other authors have described a form of this affection which differs from the ordinary variety of hydatid cyst, particularly in its structure. Instead of a cavity inclosing more or less rounded vesicles, it consists of a mass of solid tissue, strewed over with small, transparent bodies, resembling jelly. Scattered throughout the membrane are a great number of small cavities, or alveoli, which give it a worm-eaten or spongy appearance, and which vary in size from microscopic proportions to those of a hemp seed. They are filled with gelatinous bodies, which, on minute examination, are found to be composed of shrivelled hydatid membranes, echinococci, and hooklets. The tissue possesses a great tendency to ulcerate, as is evinced by one or more excavations of various sizes with ulcerated walls.

A very striking example of this form of tumor, the external appearances of which are delineated in fig. 29, came under my observation in 1869, in a German, fifty-four years of age, who had long been in the habit of eating pork.

Eight years previously, he noticed a swelling on the lower and inner side of the thigh, which, in a few weeks, attained the size of a fist, after which it remained stationary until four months before he consulted me, when it began to increase, and soon extended from the popliteal space to the pubes, occupying chiefly the inner aspect of the thigh, where it formed a soft, fluctuating tumor, from which I drew off thirty-five ounces of a dirty-brownish fluid, looking very much like ordinary yeast. One month subsequently, I laid it open by an incision twelve inches long, and dissected away the exterior adventitious sac or lining membrane. It contained many cysts, each invested by an adventitious membrane, and occupied by pus, the largest being about the size of a goose-egg. The adventitious sac was subcutaneous, two lines in thickness, and studded with small gelatinous bodies and alveoli, the former of which presented all the characteristics of ordinary hydatid membrane, and the parasite with its hooklets. The fluid in the adventitious cyst consisted of pus in a state of advanced fatty degeneration.

There are no signs by which a hydatid tumor can be satisfactorily diagnosticated. The only positive evidence of its existence, when it is seated in an internal organ, is the presence of the vesicle, or of some of its constituents, in the discharges, as the urine, sputa, or feces. It is not often that an acephalocyst is voided entire; most generally it comes away in broken pieces, or in shrivelled fragments, consisting

Fig. 29.

Hydatid Tumor of the Thigh.

of hooklets, laminated shreds, milky-looking detritus, and oily particles, discoverable with the microscope. When the tumor is situated superficially, or when it is developed among muscles, in a broad bone, the liver, kidney, or mammary gland, it fluctuates more or less distinctly on pressure, and yields the peculiar characteristic thrill, known as the hydatid fremitus. In order to elicit this sign, the fingers of one hand should be laid upon the tumor, and tapped sharply with the fingers of the other. The sensation thus communicated has been compared by Davaine to the vibrations of a repeater watch held in the hand. In some cases it closely resembles the peculiar crepitating feel produced by pressure applied to a burse of the knee or to a ganglion of the hand. A similar sensation is communicated to the ear when the stethoscope is used, and the tumor is percussed with the fingers. Not unfrequently all attempts, however patiently or skilfully conducted, utterly fail in throwing any satisfactory light upon the nature of the affection.

The diseases with which hydatid tumors are most liable to be confounded are abscesses, especially the strumous variety, hypertrophy of the liver and spleen, accumulations of bile in the gall-bladder and of fecal matter in the large bowel, aneurism of the aorta, en-

largement of the ovary and uterus, and various kinds of tumors of the abdominal and pelvic viscera, particularly the cystic, fibrous, and carcinomatous.

Treatment.—Cysts are never benefited by constitutional medication, except in so far as it may have a tendency to improve the general health, and thus retard their development. Their contents do not seem to be amenable to the action of the absorbents. When they are situated superficially and are of small size, their growth is sometimes retarded, although they are seldom cured, by compression, and by sorbefacient applications, particularly the dilute tincture of iodine. A more certain plan is to break the cysts or incise them subcutaneously, so that, their contents having escaped into the surrounding connective tissue, their walls may collapse, and ultimately unite by adhesive inflammation. When the tumor is deep-seated, iodine injections may sometimes be advantageously employed, the operation being performed in the same manner as in hydrocele of the vaginal tunic of the testicle. A seton, too, is an eligible procedure. When the cysts are large or numerous, and, above all, when the primitive textures are, in a great measure, if not entirely annihilated, the only course likely to succeed is excision of the entire mass, care being taken not to leave the slightest particle, for fear of reproduction. Too much stress cannot be laid upon this injunction. For want of this precaution, I have known a patient to be obliged to submit to not less than three distinct operations for the cure of a tumor originally not larger than a pigeon's egg. A secreting surface, hardly the size of a pin's head, is capable of reawakening growth. Removal may sometimes be effected by enucleation; at other times, and more generally, a minute dissection is necessary. The proceeding need not be at all bloody, unless the tumor is seated among very vascular parts, or the knife is carried too far away from the encysted mass.

The treatment of hydatid cysts varies according to their site. When the tumor is situated externally, as, for example, when it occupies the mammary gland, a muscle, or a bone, the only remedy is excision. When, on the contrary, it occupies an internal organ, as the liver or kidney, the proper plan is to evacuate its contents with the trocar, and provoke obliterative inflammation by the injection of a weak solution of iodine or the insertion of a tent. When no contraindication exists, a free incision may sometimes be advantageously made. Electrolysis has occasionally been successfully practised. The treatment is especially adapted to hydatids of the breast and liver. When the hydatids infest the kidney, the best internal remedies are oil of turpentine and nitrate of potassium, in moderate doses, repeated several times in the twenty-four hours.

SECT. III.—NEOPLASMS WHICH REPRESENT PERFECTED OR MATURED CONNECTIVE TISSUE AND ITS MODIFICATIONS.

1. LIPOMATOUS TUMORS.

The lipomatous or fatty tumor is not only very common, but may occur in any part of the body, not even excepting the hand, foot, fingers, and toes. It is seen, however, more frequently about the nucha, back, shoulder, and arm than in any other regions. The upper eyelid is also a common seat of it. Sometimes, but more rarely, it is developed in the orbit of the eye, the walls of the abdomen, perineum, labium, and underneath and even in the substance of the tongue. Recently I removed a small tumor of this kind from the forehead of a woman, forty-three years of age; and on another occasion one, the size of an orange, from the left temple of a man of thirty-five. Dr. Hatfield, also, met with an adipose tumor on the forehead, and Dr. S. W. Gross removed one in a middle-aged person from the occipital region. Large masses of fat occasionally form in the internal cavities of the body, as in the omentum and mesentery, and around the kidneys.

The number of fatty tumors varies, in different cases, from one to several hundred. In general, they are solitary, or, at most, there are only two or three, occupying different regions of the body, or grouped more or less closely together. In a physician, a former member of my class, thirty-eight years of age, I counted upwards of two hundred, from the volume of a small pea to that of a large marble. They all had a doughy, inelastic feel, and most of them were of a globular shape, a few being slightly flattened or compressed. They were situated principally on the forearms, inside of the thighs, loins, abdomen, and pectoral regions, the latter of which were literally covered with them. None existed on the head, neck, and upper part of the back. The general health was good, and the tumors had been first observed about sixteen years previously. During two severe attacks of acute disease, accompanied with great emaciation, many of them

entirely disappeared. The late Dr. Nott, of New York, mentioned to me the particulars of a similar case.

In their volume, these growths range from a small pea to that of an adult head. Sometimes, indeed, they are much larger, measuring many inches in diameter, and projecting a great distance beyond the surface. I am indebted to Professor Leidy for a section of a fatty tumor which weighed upwards of seventy pounds; it was removed, after death, from the abdomen of an elderly person, and contained large masses of bony matter. Dr. Bray, of Evansville, Indiana, extirpated a growth of this kind which weighed nearly forty pounds, the patient making a good recovery.

In their form, fatty tumors are generally somewhat globular, with a lobulated surface, as in fig. 30, from a specimen in my collection; as they augment in volume, however, they are liable to become elongated, and to assume a pyriform, gourd-like, or pedunculated configuration. These changes, no doubt, depend upon their weight, by which they are gradually dragged out of their original shape, as well as position. For the same reason they sometimes shift their seat, descending from the point where they originally appeared to one below it, perhaps several inches distant. Thus, a fatty tumor developed in the groin has been known, in time, to pass down between the scrotum and the thigh. This migratory tendency, which is of special interest in a diagnostic point of view, is most common in those parts of the body which are most abundantly supplied with loose connective tissue, and in those cases in which the tumor has a large bulk and a pedunculated attachment. Occasionally their edges, have a dentated arrangement, due to subordinate outgrowths of variable size and forms.

The fatty growth is always surrounded by a fibrous capsule, by which it is connected more or less firmly to the parts around, the strength of the adhesions being generally in

Fig. 30.

Lipomatous Tumor.

proportion to the age and bulk of the tumor, and the amount of pressure exerted upon it during its development. Attached to the inner surface of this covering are numerous processes, which, dipping into the interior of the growth, separate it into lobes, lobules, and granules, until the component tissues are resolved into their ultimate elements. These processes, which are usually very delicate, are occasionally, as when there is a hypertrophic condition of the connective tissue partitions, very dense and tough, forming distinct bands, of a whitish or grayish color, between the different structures.

When a fatty tumor contains an unusual quantity of fibrous matter, as when its capsule and intersecting processes are very thick and dense, it constitutes that form of morbid growth to which Müller, Rokitansky, Gluge, and other German histologists, have applied the terms mixed lipoma, steatoma, and lardaceous tumor. The name fibro-fatty would be more appropriate, although the distinction is of no practical value.

A growth in which the adipose element is intimately combined with the vascular, although not in an equal degree, is sometimes met with, chiefly upon the back, thigh, and buttock, and is known as the nævoid lipoma. It has a soft, doughy, inelastic feel, is free from pulsation, pursues a slow, indolent course, is generally congenital, is essentially composed of a cellulo-adipose basis, interspersed with enlarged veins, and occasionally manifests a recurring tendency after extirpation.

Fatty growths generally receive very little blood, and they therefore seldom bleed much when they are extirpated. It is only when they are of large size, or of very rapid development, that they are likely to be very vascular. The capsule and its processes serve to conduct the vessels into the interior of the morbid mass, and to direct, as it were, the distribution of their branches and ramifications. As the tumor is always free from pain, and tolerant of the rudest manipulation, it may be concluded that it does not receive many nerves. Absorbent vessels also exist sparingly. It may, furthermore, be inferred that, as the general health

Fig. 31.
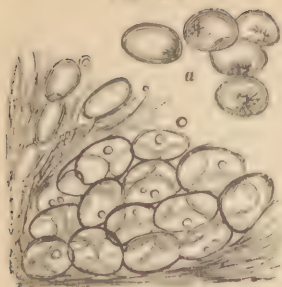
Minute Structure of a Fatty Tumor.

is usually unimpaired throughout the whole progress of the affection, however protracted, it does not possess any important sympathetic relations with the general economy.

The minute structure of this form of tumor is well displayed in fig. 31. It is made up of cells, exactly similar to, but larger than, those of natural fat, interspersed through connective tissue, as seen in the larger drawing: the small figure *a* represents isolated cells, showing the crystalline nucleus of margaric acid. Various other substances, of an adventitious character, are generally perceived under the microscope, more especially in the older growths.

The fatty tumor often sends prolongations around the muscles, tendons, fasciæ, vessels, and other structures. Thus in the neck it occasionally extends deeply between the trachea and œsophagus, dips in between the carotid artery and jugular vein, or passes down behind the sternum and clavicle into the chest. A fatty growth of the wall of the abdomen is sometimes prolonged into its cavity; and, on the other hand, such a tumor occasionally begins in the subperitoneal connective tissue, and ultimately descends through the inguinal canal, or through some abnormal outlet, down into the scrotum, thus simulating hernia of the groin. All such arrangements must necessarily greatly embarrass both the diagnosis and the attempts to remove the morbid mass.

Fatty tumors are generally easily recognized by their soft, doughy, semielastic feel, their mobility, their well-defined outline, their uniform consistence, their lobulated surface, their tardy progress, and their indolent disposition. Some are pedunculated, some pendulous, some pyriform, or gourd-like, some flattened, as if compressed, and some ramiform, processes extending in different directions among the muscles, vessels, and other structures. There is no pain, no tenderness on pressure, no impairment of the health, no enlargement of the subcutaneous veins, and no inconvenience, except what is occasioned by the situation, bulk, and weight of the growth.

Inflammation, suppuration, ulceration, and even gangrene may occur in these growths, usually induced by mechanical pressure, caustic applications, or inefficient nourishment, in consequence of a loss of their vascular and nervous supply from the pendulous or overgrown character of the morbid mass. In a tumor of this kind, about the volume of an orange, which I removed from the top of the left shoulder of a girl eighteen years of age, the ulcer had a remarkably foul, unhealthy aspect, with thin, everted edges; the pain was, at times, very severe, and the discharge was of a sanious nature, intermixed with globules of fat. Various attempts had been made, but without success, to heal it up, and no cause could be assigned for its formation. The general health had been a good deal impaired, and there had latterly been some irregularity of the menstrual function. The ulcer was included in two incisions, and speedy recovery was the result.

Again, such tumors now and then undergo the fibrous, cartilaginous, calcareous, or osseous degeneration, not uniformly, but at certain points of their extent. Nodules, varying in size from a hazel-nut to a pullet's egg, may thus be formed, having a firm, characteristic consistence, more or less movable, and contrasting singularly with the other structures. Finally, they occasionally contain cysts filled with various kinds of substances, as oily, serous, mucous, or gelatinous. The walls of the cysts may be very thin and transparent, or thick, opaque, and perhaps even partially calcified.

Fatty growths generally arise without any assignable cause. Sometimes, though very rarely, their development is apparently due to external injury, as a blow, contusion, or persistent mechanical compression. It is most common in young adults and middle-aged persons. Occasionally it is congenital, as in the interesting cases reported by Johnson, Gay, and others.

The medical treatment of this class of morbid growths is most unsatisfactory, as there is no remedy which seems to be capable of arresting their progress, or of causing their removal. The instance of Sir Benjamin C. Brodie, in which he succeeded in dispersing a large mass of fat from a man's chin and neck, by the free and persistent use of the officinal solution of potassa, may be regarded as a remarkable example of good luck. All local means, as systematic compression, and sorbefacient lotions, liniments, and unguents, are equally useless, the absorbent vessels being seemingly incapable of responding to their action.

The manner of excising such tumors is generally sufficiently simple. Any diseased skin that may exist should be removed along with the morbid mass, which should be enucleated

by a rapid dissection, care being taken that not a particle of the tissue is left behind; otherwise reproduction may take place. When the tumor is superficial, the operation is easily performed and soon over; but when it is deep-seated, or when it sends processes among the surrounding structures, it may be one of great difficulty and perplexity, requiring consummate skill and a most thorough knowledge of the anatomy of the parts. A fatty tumor that has long been compressed, as when it occupies the nape of the neck, shoulder, or buttock, is often removed with difficulty, owing to its firm and extensive adhesions. For the reasons already mentioned, the operation is sometimes nearly bloodless. I have, indeed, seldom found it necessary to apply more than two or three ligatures, whatever may have been the volume of the tumor.

When a fatty tumor is completely extirpated, there can be no recurrence of it. In a case of lipoma of the scrotum, recorded by Mr. Curling, in which there was a reproduction five times, the new product was evidently merely an outgrowth of a part of the pedicle which in each instance had been left behind.

2. FIBROUS TUMORS.

The fibrous tumor owes its name to its peculiar structure, which strongly resembles normal fibrous tissue. One of the best examples of this variety of morbid growth is to be found in the uterus of elderly females, where it sometimes attains a weight and magnitude equal to those of the body of the patient. It also occurs in the connective tissue, both subcutaneous and intermuscular, in the mammary gland, testicle, ovary, periosteum, bones, nerves, and other parts of the body. In my cabinet is a large fibrous tumor, weighing nearly five pounds, which I removed from the interior of the scrotum of a young man of twenty-five, but which had no connection whatever with the testicle. A remarkable fibrous tumor sometimes grows pendulously from the lobe of the ear. Certain keloid formations of the skin obviously belong to the present class of morbid products, although they usually contain an inordinate quantity of fibroplastic tissue. Fibrous growths occasionally occur in the interior of the joints, especially the elbow and knee, in the latter of which they sometimes attain the volume of a pullet's egg. The dura mater, periosteum, and fibrous envelop of the muscles are all liable to such formations, although the occurrence is unusual. Finally, fibrous tumors are often met with in the neck, either immediately beneath the skin or deep among the muscles and lymphatic glands. Not long ago I removed from a lady, forty-three years of age, a small nodule of this kind from the site of the lachrymal sac, which was almost completely obliterated by its pressure. Certain polyps, as they are called, are of a purely fibrous structure.

This growth is not peculiar to any period of life. The greatest number of cases, perhaps, occur in young adults. In the uterus and ovary it is most common in elderly subjects. It is sometimes congenital, and I have met with it also in several members of the same family.

The fibrous tumor, although of slow growth, may eventually acquire an enormous bulk, as is exemplified in the immense masses which are occasionally found in the neck, the uterus, and other parts of the body. It feels heavy and incompressible, is globular, ovoidal, or pyriform in shape, and has generally a smooth, even surface, although not unfrequently it is remarkably lobulated, or marked by numerous elevations and depressions. In the uterus and the joints it is often attached by a narrow neck, while almost everywhere else it is in immediate contact, on all sides, with the structures in which it is developed, its adhesions being effected by connective tissue. Generally solitary, it occasionally occurs in considerable numbers, more particularly in the uterus, which is sometimes completely crammed with it. In the case of a woman, sixty-six years old, Lebert found several hundred fibrous tumors scattered through the subcutaneous connective tissue in different parts of the body. In the nerves upwards of one thousand have been observed in the same person.

The structure of this tumor is characteristic. As its name indicates, it is composed of fibrous tissue, the filaments of which cross each other in every conceivable manner, forming thus an intricate network, which the most careful dissection fails to unravel. These filaments are of variable size and shape, and are so intimately compacted together in the firm variety as to form a dense, hard, inelastic substance, so characteristic of this kind of product. It is only in rare cases that their passage across each other leaves any interspaces for the lodgment of fluid or solid matter. They are of a grayish or pale drab color after maceration, but in their natural state rosaceous, reddish, or even purple, their complexion depending upon the amount of blood they contain. Occasionally they have a

whitish, silvery, glistening appearance, like the sclerotic coat of the eye. The soft variety, as, for example, the molluscous fibroma, possesses a looser and a less dense texture, resembling that of the subcutaneous connective tissue, and its color is usually white, reddish, or yellowish.

The fibrous tumor has seldom any distinct capsule ; the tissues around it are, it is true, usually a good deal condensed and thickened, but the covering thus derived is altogether adventitious and secondary, forming none of the essential elements of its growth. Few vessels can be traced into its substance, and these are rarely of any considerable size ; a circumstance the more surprising when it is recollected what immense bulk it sometimes acquires. No reliable chemical examination has been made of this variety of tumor, but it is probable that it consists essentially of gelatine, as this substance is largely furnished by protracted boiling. Under the microscope it exhibits hypertrophied fibres, between

Fig. 32.
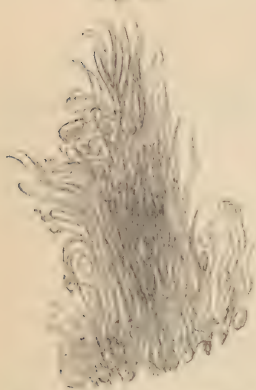
Microscopical Characters of Fibrous Tumor from the Submaxillary Region. ×472 Diameters.

which are interspersed, sometimes in great numbers, small ovoidal or fusiform cells, containing bright nuclei, which are always rendered very conspicuous if the part be previously treated with acetic acid, as in fig. 32, from a drawing of one of my specimens by Dr. Packard.

A fibroma sometimes contains mucus, the result of softening, lodged in distinct cells or cavities, and giving rise to a mixed form of tumor, known as the myxomatous fibroma. The presence of the mucus probably serves to give additional impulse to the development of the tumor, which occasionally increases with remarkable rapidity, and soon acquires a large bulk in consequence.

The general tendency of the fibrous tumor is gradually to increase, to impair function, and ultimately to wear out life by its secondary effects. The older formations of this kind nearly always contain adventitious deposits, especially the calcareous, which often exist in considerable quantity. The cartilaginous is also not uncommon, while the osseous is rare. Sometimes large cavities, containing serum, pus, and other substances, are found in them. In a case observed by Paget, a fibrous tumor of the uterus contained a mass of fat the size of a large walnut.

Their progress is usually painless, except when they compress important parts, the inconvenience which they occasion being dependent mainly upon their weight, bulk, and site.

A growth of this kind sometimes takes on malignant action, its tissues serving as a nidus for sarcoma. Although it is impossible to determine what are the circumstances which predispose to, or influence, such an occurrence, there can be no doubt that it is governed by the same laws as those which preside over the development of sarcoma in the connective tissue generally, and that the change does not consist in a degeneration, properly so termed, of the fibrous substance, but in an entirely new formation. The neoplasms, which were described in former editions as fibroplastic and recurring fibroid tumors, will be discussed in the section on sarcoma.

The diagnosis of the fibrous tumor must mainly be deduced from its history and its consistence. Its growth is generally very tardy, there being a marked difference, in this respect, between it and the carcinomatous formations. Usually beginning in a little hard nodule, or lump, several years commonly elapse before it attains any considerable bulk, especially when it is developed among the external tissues ; its progress is comparatively painless, the chief inconvenience occasioned by it being of a mechanical nature. The tumor usually feels hard, firm, and inelastic, being more dense than encephaloid, but not so solid and dense as scirrhus. Its consistence is usually uniform ; not hard at one point and soft at another. Its surface, too, is commonly smooth ; and there is nearly always, unless the growth is very large, an absence of enlargement of the subcutaneous veins. In its earlier stages it is somewhat movable, except when it springs from the periosteum ; by degrees, however, it contracts adhesions, and is thus firmly fixed in its position.

The fibrous tumor is rarely amenable to local or constitutional treatment. When favorably situated, pressure, steadily and systematically applied, is sometimes serviceable : but this is so seldom the case that hardly any calculations of a curative character are to be based upon it. In the early stage of the development, before any great firmness and density of structure are attained, a mild course of mercury may be tried, its constitutional impression being persistently but very gently maintained for several successive months, or alternated with that of iodide of potassium, also an agent of some consequence in the

softer forms of fibrous growths, although rarely of any benefit in those of maturer development. But the surest remedy, when the tumor is accessible, is removal, performed early and efficiently, by dissection and enucleation. Hemorrhage is usually slight, and recurrence not probable, unless, as sometimes happens, the morbid mass has become the nidus of sarcomatous deposit. As this cannot always be certainly predicted, the prognosis should not be too sanguine.

3. CARTILAGINOUS TUMORS.

The cartilaginous tumor, first accurately described by Professor J. Müller, under the name of enchondroma, or chondroma, holds, histologically, a position intermediate between the fibrous and osseous, and is harder than the former and softer than the latter. It is divided by Virchow, primarily, into ecchondroses, which spring from the permanent cartilages, and enchondromas, which are developed from a non-cartilaginous basis. The former, which do not differ from the latter in their clinical history and minute structure, have a predilection for the costal, pelvic, laryngeal, and tracheal cartilages, and they also form the movable bodies of the articulations.

Enchondroma occurs in various parts of the body, as the parotid and submaxillary glands, the testicle, and ovary, as well as in the subcutaneous and intermuscular connective tissue, but is most frequent in the skeleton, as the metacarpal bones and the phalanges of the fingers, where it may be central or periosteal. I have seen large and numerous growths of this kind form simultaneously upon both hands and both feet, causing hideous deformity and almost complete loss of function of the affected parts. The most formidable tumors of this kind are generally met with in the scapula. Although they occasionally occur in elderly subjects, they are by far most common in young persons before the twentieth year, especially in such as are of a weak, rickety constitution; and they are often associated with a remarkably stunted state of the body. The annexed sketch, fig. 33, from a specimen in my possession, conveys a good idea of the external characters of an enchondroma of a finger.

The enormous size which a cartilaginous tumor is capable of attaining is well illustrated in a case which came under my observation in a young man, twenty-six years of age. The tumor, which occupied the right shoulder, had appeared about six years previously, and involved the scapula, humerus, and clavicle, forming an immense mass, of very irregular outline, excessively hard, forty-five

Fig. 33.

Enchondromatous Tumor.

inches in circumference at the base, and weighing, after death, as was ascertained by Dr. H. J. Bigelow, thirty-one pounds. In another instance, one which I saw with Dr. Davison, of Illinois, in a man forty-five years of age, an enormous mass of this kind, having its origin in the scapula, and occupying the left side of the trunk, weighed ninety pounds. In a case of enchondroma of the femur, related by Sir Philip Crampton, the tumor measured six feet and a half in circumference. Mr. Gamgee, in 1862, amputated successfully at the hip-joint, in a case in which a growth of this kind, along with the thighbone, weighed ninety-nine pounds.

The structure of enchondroma corresponds with the type of permanent cartilage, consisting either of hyaline, fibrous, or reticular tissue alone, or, as is nearly always the case, of all those varieties variously intermingled, so that, in reality, most tumors of this kind are of a mixed character. Portions of it undergo different transformations, and in cases of long standing, or of extraordinary bulk, mucous, fatty, fibrous, cartilaginous, calcareous, osseous, and sarcomatous changes are almost always met with. It also not unfrequently contains large cysts filled with various kinds of substances, either solid or fluid. To the hand it imparts the sensation of unusual firmness and solidity; it is destitute of elasticity, is generally distinctly circumscribed, and is nearly always strongly adherent to the tissues from which it springs. Its surface, which is sometimes smooth, is commonly lobulated, or marked by irregular prominences and depressions. No pain usually exists, or, if there be any, it is owing rather to the pressure which the tumor exerts upon the neighboring parts than to any disorder of its own sensibility. When the growth is very old and bulky, there is generally great enlargement of the subcutaneous veins, with a tendency to softening and disintegration of its more feebly organized portions.
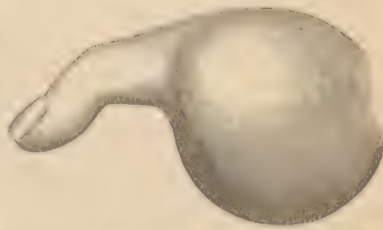
The cartilaginous tumor varies in consistence, not only in the different stages of its life, but in different portions of its extent. The older sections are generally hard, firm, dense, cutting with difficulty, and creaking under the knife; the younger, on the contrary, are soft, almost gum-like, or of the consistence of honey, warm glue, isinglass, or synovia. Sometimes almost the entire tumor is semiliquid; at other times the fluid matter is contained in distinct cysts or cavities, and in some cases, again, the fluid parts are intermixed with fibrous, cartilaginous, or osseous nodules. The softer portions may be present as an original product, or they may be the result of secondary formation, consequent upon deficient nutrition, or retrograde, degenerative changes. On section, it is of a whitish, grayish, or bluish aspect, and is characterized by a peculiar linear or lobular arrangement.
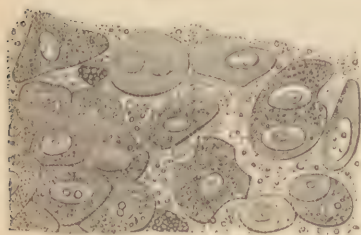
Fig. 34.

Microscopical Characters of Enchondroma.

Under the microscope this tumor presents numerous cells, as in fig. 34, of an oval or rounded shape, from the $\frac{1}{700}$ to the $\frac{1}{1500}$ of an inch in diameter, provided with one or two nucleolated nuceli, and lodged in cavities of various sizes and forms, distributed through an amorphous hyaline, mucous, dimly fibrilliated, or coarsely fibrous, intercellular substance. In the older growths, some of the cells are cloudy and shrivelled, others are in a state of fatty degeneration, while others, again, are marked by projections similar to those of cartilage in process of ossification. Its principal constituent is chondrin in union with phosphate of lime. The animal matter, readily extracted by boiling, solidifies on cooling like gelatine, but does not contain any of the latter substance, as is shown by the fact that it does not expand by contact with fluids.

The cartilaginous tumor is sometimes inclosed by a distinct cyst of condensed connective tissue; at other times it is in immediate contact with the structures in which it is developed. Its vascularity is often very great, a circumstance which readily explains the astonishing rapidity which occasionally marks its progress, cases having been observed in which, in the course of a few months, the tumor attained the size of an adult's head, or even of the patient's chest. Such an occurrence, however, is extremely uncommon; for the development of enchondroma is usually singularly tardy, and now and then, it apparently enjoys even a period of repose.

Enchondroma is generally painless and indolent, causing little or no inconvenience, save what results from its weight and pressure; sometimes, however, it inflames and ulcerates, and in this way a large cavity may be formed, attended with copious discharge and excessive constitutional disturbance, rapidly followed by hectic fever. Portions of it may, as already stated, undergo various transformations, as the cystic, fatty, fibrous, calcareous, and osseous; and segments occasionally degenerate into malignant disease, nodules of cartilage, of various shapes and sizes, being interspersed through the sarcomatous tissue, each invested by connective tissue.

Although the cartilaginous tumour is generally an innocent growth, it sometimes assumes a malignant form, and numerous instances have been reported in which it recurred after extirpation, not only once but repeatedly. The recurring tendency is well exemplified in the remarkable case observed by the late Dr. Reuben D. Mussey, in which the disease successively invaded the hand, arm, and shoulder, the second operation being performed thirteen years after the first, and the last, in which the entire scapula and clavicle were successfully removed, five years after the second. Syme performed amputation at the shoulder-joint, in a girl, fourteen years of age, on account of a cartilaginous tumor which reappeared in the stump and in the axilla. In two cases, recorded by Gluge, the disease returned and destroyed life, respectively, at eighteen months and two years and a half. Virchow relates an instance in which an enchondroma of the scapula recurred seven times, and finally proved fatal. Under such circumstances similar growths are frequently found in other organs, as the lungs, liver, spleen, and testicle. The extension of cartilaginous tumors, by the lymphatic vessels, has been repeatedly observed, the vessels being remarkably tortuous and dilated, and filled with cartilaginous matter. It is not, however, at all certain that in the recorded cases of malignity of enchrondroma the tumor was constituted by cartilage alone; and I am of the opinion that the cartilaginous tumor never occasions secondary deposits, unless it is combined with sarcoma, myxoma, or carcinoma.

The only remedy for this tumor is early and efficient extirpation. The operation,

however, as already stated, is not always successful, for now and then repullulation occurs, either causing death, or demanding further surgical interference. This is especially liable to happen when the tumor sends out small processes into the surrounding structures, or is not distinctly incapsulated, and when sarcomatous elements are intermingled with the cartilaginous. When the new growth is closely connected with bone, amputation will always be required.

4. OSSEOUS TUMORS.

Osseous tumors, or osteomas, usually known as exostoses, are met with chiefly as outgrowths of the skeleton, especially of the skull and thigh-bone, the superior jaw, the orbit of the eye, and the distal phalanx of the big toe, occurring in various forms and sizes, from a pea up to a fœtal head; hard and compact, like normal bone, which they closely resemble in structure and composition; slow and painless in their progress; seldom, if ever, degenerating into malignancy; unamenable to ordinary medication; and demanding removal only when they seriously interfere with the exercise of important functions. Osteomas, not directly connected with bone, or continuous with bone, occasionally occur as the result of ossification of the cartilaginous, muscular, tendinous, and aponeurotic tissues, but their consideration does not properly belong to the present subject; and a similar remark is applicable to those peculiar osseous formations which are sometimes met with as isolated bodies, of varying forms and sizes, in the substance of different organs, as the brain, lung, ovary and testicle, and in connection with different kinds of soft tumors. A well-marked exostosis, constituting what is called an odontoma, occasionally forms on the root of a tooth, especially of the large grinders.

Osseous tumors, properly so called, are, in reference to their structure and mode of growth, divisible into two classes, the soft, spongy, or cancellous, and the compact, hard, or ivory-like. The former, which is by far the more common, has usually a cartilaginous origin, and is often, especially in its earlier stages, invested by a layer of this substance, from one to several lines in thickness, of a grayish, whitish, slightly bluish, or pearly aspect, and of a hyaline character. Sometimes it is inclosed by a thin fibrous capsule, a form of synovial burse, lubricated by serous or sero-oleaginous fluid. Such an arrangement is most common in osteomas near the larger joints, in connection with the epiphyses of the long bones, and is evidently designed to facilitate the movements of the soft parts immediately around the morbid growth.

In its shape the cancellous osteoma is generally more or less rounded, with a nodulated surface, and a broad base; occasionally it is very irregular, spiculated, or angular; and now and then it has a distinctly pedunculated form. It is of a dense, firm, bony consistence, and is only movable while it retains its fibrous, periosteal, or cartilaginous attachment. Its volume usually ranges between a pea and an adult fist, although it is capable of acquiring much larger dimensions. The structure and chemical composition are as nearly as possible like those of normal bone, both in its compact and medullary substances. Cancellous osteomas sometimes arise in the medullary canal and within the frontal sinus, forming thus what, in strictness of language, may be called enostoses, which, however, in no wise differ in structure and composition from exostoses, or external bony outgrowths. The most frequent seats of the cancellous exostosis are the femur, tibia, fibula, and humerus.

The ivory-like tumor is destitute of cancellous substance, and is so firm and dense as to be severed with great difficulty, the section admitting of a fine polish, very much like the substance to which it owes its name. Phosphate and carbonate of lime are present in unusual quantity, although it is not improbable that its hardness depends more upon the mode of aggregation of its several constituents than on chemical differences. The Haversian canals and lamellar arrangement are always well marked. Of a rounded, globular, or hemispherical shape, the morbid growth is generally smooth, or slightly nodulated, of small size, and attached by a narrow base, often of a cartilaginous character. Its most common site is the skull, and it may grow either from the outer or the inner table; more generally the former.

Osteomas are generally of slow growth, and the principle inconvenience occasioned by them arises from their situation, bulk, weight, and pressure. Severe pain, mostly of a dull, heavy, aching character, may be produced by them when they overly, inclose, or compress important nerves. The general health is usually unaffected. The diagnosis is easily established by the history of the case, and by the firmness, density, and immobility of the tumor, which are greater than those of any other morbid growth. The cau-

cellous osteoma is most common in young subjects, before the twenty-fifth year; the ivory-like in advanced age. Of the nature of their exciting causes nothing definite is known. Their origin, in many cases, is directly traceable to external injury; and instances occur in which there is a veritable exostotic diathesis, exostoses, sometimes of a symmetrical character, existing, perhaps, upon almost every bone in the body. A hereditary tendency to these outgrowths is occasionally witnessed; and I have met with examples of them in several members of the same family.

It is possible, I presume, for an osteoma, under the influence of injury, protracted pressure, and general ill-health, to assume malignancy; but such an event is extremely uncommon. The occurrence of caries and necrosis is also very infrequent. A sponta-neous cure sometimes takes place, the growth, from the interruption of its circulation, losing its vitality, and finally dropping off as an extraneous substance. Such an event is most common in osteomas of the head and face. Medication is of no avail in arresting the progress of the disease, except when the tumor is very small and young, when sorbe-facient applications, judiciously employed, are occasionally of use. As long as the growths cause no serious inconvenience they should not be subjected to operative interference, as the patient might perish from erysipelas, pyemia, or profuse suppuration. The bursal covering of an exostosis seated on the epiphyses of the long bones sometimes opens into a neighboring joint, rendering such interference doubly perilous.

5. LYMPHOMATOUS TUMORS.

A lymphoma is a neoplasm composed of a tissue similar to that of the follicles of the lymphatic glands, or the adenoid tissue of His, which, as is now well known, is widely distributed throughout the body, being found not only in the lymphatic glands, but in the parenchyma of the various organs, the medulla of the bones, the tonsils, the pharynx, and the mucous membrane of the intestinal tract. In France the growth is called lym-phadenoma; but as that term is also applied to the affection which in England is styled Hodgkin's disease, it should be discarded. By other writers the term lymphosarcoma is loosely employed as the equivalent of lymphoma, which is altogether improper, as the two affections differ widely from each other in their minute structure and in their clinical features. In the following description the term lymphoma will be employed as signifying progressive hyperplasia of preëxisting lymphatic tissue, and has, therefore, nothing in common with sarcoma, or the enlargements due to ordinary inflammation, struma, syphilis, tubercle, Hodgkin's disease, or lymphatic leukæmia.

Fig. 35.

Minute Structure of Lymphoma.

Viewed in the sense here indicated, the lymphomatous tumor is most frequently met with in the neck and axilla, the glands of which usually enlarge with great rapidity, and finally constitute bulky growths. The tumor itself is free from attachments, and the individual glands of which it is composed remain encapsulated and thoroughly independent of each other, ex-cept through their union by loose connective tissue, are generally kidney-shaped, or long-oval, and of a soft, semielastic consistence, movable under the skin, free from pain, or nearly so, and tolerant of rude manipulation. Their sectional surface is of a grayish, light-pink, or reddish-yellow color, sometimes mottled with minute points of extravasated blood, and yield on pressure a whitish, lactescent juice, not unlike that of encephaloid carcinoma.
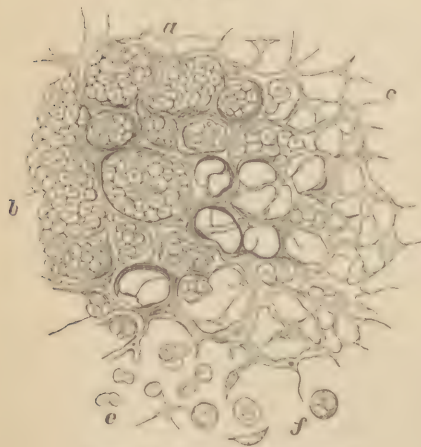
The minute appearances are well exhibited in fig. 35, from O. Weber, representing a fine section of an enormous tumor of this description removed from the axilla of a boy. At c, the delicate meshes of the reticulated struma are seen, freed from the corpuscles by pencilling; while at a and b, the alveoli are crowded with lymph corpuscles, which at e and f are undergoing active proliferation by division and endogenous germination. In the soft form of lymphoma the lymph cells predominate, and the connective tissue of the

follicles exists as a very delicate reticulum, while in the firm variety the reticulated stroma is much increased in thickness and the cells are diminished in number.

These tumors are most common in adults between the ages of twenty and thirty-five, but they are sometimes observed in children. Their ordinary course may be thus described : Commencing on one side of the neck, for example, usually below the angle of the jaw, all the glands are successively invaded until the great anterior and posterior triangles and the supra-clavicular fossa are filled by the growth. After a period, which varies from four to eighteen months, the glands of the axilla and the opposite side of the neck become involved, followed by those of the mediastinum, bronchiae, and mesentery, as is indicated by chest troubles and impairment of the general nutrition. The patient is pale, weak, anemic, has a poor appetite, sleeps badly, becomes dropsical, and finally dies utterly exhausted.

The diagnosis of the disease in its earlier stages from simple inflammatory or scrofulous enlargement of the glands is impossible ; but its signs are so characteristic after it has made some progress that its nature is unmistakable. Its distinctive features are, its occurrence in young and vigorous subjects ; its limitation to one side of the body ; its progressive, rapid, and indolent growth, without any tendency to suppurate or extend beyond its capsule and to infiltrate the adjacent tissues ; the mobility of the glands under the skin ; the natural condition of the skin in regard to color and freedom from adhesions ; the successive involvement of the contiguous glands ; its elastic consistence and lobulated outline ; and, finally, the absence, in its early stage, of a cachectic state of the system. Lymphosarcoma, on the other hand, occurs later in life ; is painful ; usually commences in a single gland ; soon extends beyond the limits of its capsule to infiltrate the adjacent tissues, and convert them into a fixed, confused, and inseparable mass, and the overlying integument rapidly becomes adherent and discolored, and finally ulcerates.

Lymphomatous tumors, considered in the restricted sense in which they are here described, are of evil import. The firm form frequently recurs after extirpation, and progresses more tardily to a fatal termination than the soft variety. The latter, which is the more frequent, is excessively liable to occasion secondary deposits in the lungs, liver, spleen, kidneys, mediastinal, bronchial, mesenteric, and retroperitoneal glands, the intestinal tract, the osseous system, and the brain, and in point of malignity is not surpassed by carcinoma.

The most important remedies are chalybeate tonics, quinine, cod-liver oil, nutritious food and drinks, and a change of air. Mercury is generally hurtful, and friction with stimulating liniments and unguents should be avoided. From the arsenical treatment, so much lauded by some German surgeons, which consists in the exhibition of Fowler's solution in gradually increasing doses, and the injection of that remedy into the tumor, I have not met with decided results, nor have I been more successful from extirpation. The disease is very liable to go on from bad to worse despite all our attempts to arrest its progress, death finally taking place from sheer exhaustion.

SECT. IV.—NEOPLASMS WHICH REPRESENT EMBRYONIC, IMMATURE, OR UNRIPE CONNECTIVE TISSUE.

1. SARCOMATOUS TUMORS.

Sarcoma embraces an entirely distinct class of tumors, which hold an intermediate position between benign and malignant growths, inasmuch as they have a local, innocent period, during which they are amenable to the knife, while later they may assume a malignant form, as exhibited by their constant tendency to recurrence after removal, and the development of metastatic or secondary deposits in distant tissues and organs. It is by far the most interesting of the histoid neoplasms, presenting, as it does, in its clinical history, features similar to and yet dissimilar from those of carcinoma, and differing widely from the latter in its histological construction, the distinction between them being that carcinoma is characterized by a marked alveolar formation of its stroma, the loculi being crowded with cells of an epithelial type, while in sarcoma the cells are of the type of the developmental series of the connective tissues, and mingled with the intercellular substance. In its pure form, no tumor can be more simple in its character, as it consists of imperfectly elaborated elements, which have no similarity to any normal structure of adult life, and which never advance to higher development. A sarcoma may, therefore, be defined to be a tumor composed almost entirely of cells, which have their origin in those of the connective tissues, and persist as such, although greatly enlarged and increased in number. The structure of such a growth is, then, only distinguishable from that of the

connective-tissue series, by the excessive preponderance, development, and arrangement of its cellular elements, which constitute its peculiar features.

The connective tissues proper, whether subcutaneous, submucous, subserous, intermuscular, or fascial, are always the starting-points of sarcoma. It often, however, arises from other structures of this series, as, for example, the delicate, supporting, retiform tissues of the nervous centres and the lymphatic glands, the periosteum and osseous marrow, when the histological peculiarities of the matrix are usually propagated to it. Thus, sarcomas of the choroid and skin produce pigment cells; spindle cells predominate in those which originate in aponeuroses; while periosteal sarcomas evince a disposition to osseous formations, so that they are distinguished by the similarity of their structure to one or another of the group of connective tissues, as fibrous, mucous, glious, lymphoid, cartilaginous, osseous, or pigmented. They may, moreover, spring from the connective tissue of other neoplasms, as is frequently seen in carcinoma, some segments of which present sarcomatous characters, and they possess, in a remarkable degree, the power of combining among themselves, several different tissues existing in the same growth, thereby giving rise to mixed tumors.

The cell elements of sarcoma, like those of the tissues from which they are developed, are round, spindle-shaped, or stellate, existing either separately or in conjunction in the same tumor. In the latter event, the most common of all, one form always predominates, and it is in accordance with the preponderance of one or the other kind of cell that three principal forms of sarcoma are recognized, namely, round-celled, spindle-celled, and giant-celled. In all of these the cells, as a rule, are hypertrophied; the nuclei and nucleoli are especially enlarged and increased in number, the former often attaining the size of the largest normal cells. Round cells are found in all sarcomas, and are often very small, as is seen particularly in the glious variety. They are extremely friable, thereby producing the appearance of free nuclei in recent preparations, and, for the most part, resemble lymph corpuscles, colorless blood corpuscles, and granulation cells, from which they cannot be distinguished, unless it be by the relatively large dimensions of the nucleus, and, occasionally, of the cell itself. Spindle cells are very easily recognized. They consist of a dimly granular, pale, fusiform body, which terminates at each end in a long, delicate, perhaps subdivided, filamentary process. The nucleus, which contains one or more nucleoli, is usually single and well defined, and of an ovoid or elliptical form. Giant cells, which are commonly associated with the round and fusiform elements, are very characteristic, and are similar to the flat protoplasms that are found in the marrow of fœtal bones. They are the largest of human cells, and often attain extraordinary dimensions. Their substance is finely granular, and contains very numerous, not unfrequently even hundreds of oval, nucleolated nuclei. Their form, which is very variable, is generally irregularly ovoidal or polygonal; and rounded or filamentous processes not unfrequently shoot out from their bodies.

The form and number of the cells are so varied that they cannot alone be considered as decisive of the variety of the sarcoma, but it is their arrangement and development that are characteristic, as will be seen when the structure of the different tumors of this group is considered. They are placed side by side, either in contact with each other, or only separated by a minimum quantity of intercellular substance, the nature of which determines, in great measure, the subdivisions of sarcoma, but not of the sarcoma itself.

The matrix, or intercellular substance, is rarely collagenous or pure connective tissue capable of yielding gelatine on boiling, but generally of an albuminous, mucous, or glious nature. It is always present to a greater or less extent, and may be homogeneous, granular, or fibrillated. It occurs in small proportion in spindle-celled and giant-celled tumors, but is very abundant in the soft, rapidly-growing, small-celled sarcomas, imparting to them a sensation of fluctuation. In fibrous sarcomas it is distinctly fibrillated; in the lymphoid variety it forms a delicate network; in glious and some mucous sarcomas, it is usually amorphous and granular; while in some again of the latter it is frequently hyaline and homogeneous. Finally, one variety of cell may form the matrix of a tumor composed of an entirely different cell, and it is not at all uncommon for spindle cells to play this rôle in gaint-celled sarcomas of the bones.

Bloodvessels exist in great abundance in all sarcomas, pervading them in every direction, and forming more or less loose capillary networks, in the meshes of which the cells are contained. When the vessels are large, they are surrounded by a supporting connective tissue, which assists in giving a retiform appearance to some tumors, but when they are minute the cells, like those of granulation tissue, lie directly in contact with their walls, from which it is difficult to isolate them. In soft sarcomas, the capillaries are

rarely seen to consist of proper walls, but their lumen appears to be limited by round or spindle cells, and this disposition of their constituent elements, or vascularization of an almost purely cellular tissue, serves as a point of distinction between these and other neoplasms. In some cases the vessels are greatly enlarged, and are so numerous as to constitute telangiectatic or erectile sarcomas, which, from their great tendency to hemorrhage, represent one of the forms of fungus hematodes of former writers. In other cases they give rise to pulsating tumors, containing collections of blood, which include, in part, those formations known as aneurism of bone.

Of the causes of sarcoma little is known; for, although it sometimes shows itself soon after birth, it is doubtful whether it is ever of an hereditary character; it is often spontaneous in its origin, but is most frequently traceable to local irritation and external injury.

It appears in both sexes with about equal frequency, and, although it may occur at any period of life, is generally met with between the twentieth and the fortieth year, being rare before the second decade and uncommon after the latter period. The age of the patient, however, influences the liability of the affection in different organs. Thus, medullary sarcoma of the genital organs, particularly of the testicle, is more frequent about the age of puberty; retinal glious sarcoma is almost peculiar to infancy; osseous sarcoma is most common in young persons, while pigmented sarcoma usually occurs late in adult life. No reliable data exist as to the relative frequency of the seat of the disease. It is most common in the skin and subcutaneous and intermuscular connective tissues of the extremities. Periosteum and bone, particularly the epiphyses of the long bones and the maxillæ, are highly obnoxious to it. It is more rarely met with in the lymphatic glands and the secreting glandular organs; among the latter, the female breast and the testicle are its favorite seats. The eye is not unfrequently affected; while the serous and mucous membranes occasionally are its primary seats.

Sarcomas usually arise in the form of nodules, single or multiple; they may be firm or soft, and are distinguished from all other neoplasms by the rapidity of their growth, through which they often, in a short time, attain enormous dimensions, as is seen particularly in those connected with the periosteum and lymphatic glands. This increase in volume is, in part, central, through proliferation of preëxisting cell elements, and, in part, peripheral, by extension to the continuous tissues. If the former process predominate, the tumor is incapsulated, as is exemplified in fibrous sarcomas; whereas if the growth be due to extension by local infection, it is diffused, as is witnessed in soft, small-celled sarcomas. Their tendency is progressive. Although there may be a temporary arrest of development, extending even through a number of years, during which they are stationary, they usually, under the influence of some exciting agent, external or constitutional, awaken into activity and proceed regularly to their termination. Retrogression, through fatty metamorphosis of the cells, is almost constant in old, voluminous tumors, but it is rarely observed to affect the entire mass. The central part may recede, but, at the same time, the remainder increases more luxuriantly, and there is probably not a well-authenticated case on record of a spontaneous cure through absorption of the emulsified fatty detritus. Fatty degeneration occurs generally in those forms which are very soft, rich in cells, and increase rapidly, as the glious and mucous medullary sarcomas, converting them into a caseous material, resembling broken-down gummy substance. Through the same change, the harder, fibrous forms are converted into dense cicatricial tissue, poor in cells, not unlike that of atrophic scirrhus; but cicatricial shrinkage is uncommon. Calcareous and osseous transformations take place in portions of those tumors which are connected with bone, as is evinced by the production of irregular, radiating, delicate spicules or plates. At other times, and especially in large, medullary growths, softening ensues, which may end in ulceration; or the detritus may be absorbed, leaving cavities, which become filled with a serous fluid, thereby forming species of cysts. In some cases, during the process of softening, the bloodvessels are eroded, causing extensive parenchymatous hemorrhage, in which event the sarcoma, now and then, is converted into a species of blood cyst, obscuring the original characteristic elements, which can then be discovered with difficulty, and only at the periphery. Sarcomas of the skin ulcerate early, but the destruction is not great. In general, these tumors exhibit little tendency to ulcerate, particularly the firmer forms, for which reason the fibrous sarcomas may attain an enormous size. The soft, rich-celled sarcomas are more disposed to this change, but it appears later than in carcinoma. When it has once occurred, the ulcer rapidly increases, has a foul, fungous appearance, and the accompanying discharge, often bloody, sometimes putrid, is very abundant. If the hemorrhage and suppuration are profuse, symptoms of anemia rapidly supervene. Coincidently

with, but seldom before, the ulceration, pain sets in, the general strength fails, the internal organs become affected with secondary deposits, and the patient finally succumbs either from complications or accidents due to metastatic infection, septicemia, or exhaustion, induced by the combined effects of anemia, prolonged suffering, and profuse discharges of blood and pus.

Malignity is a very decided attribute of sarcomas, exhibiting itself not only in a constant tendency to local recurrence, after extirpation, but also in its power of metastatic diffusion. Locally, the infection extends, first, to the neighboring homologous tissues, often far beyond the apparent limits of the tumor, a circumstance which explains its disposition to repullulation; and, subsequently, it advances, by continuity, to the heterologous tissues. Secondary nodules, often in enormous numbers, and almost invariably presenting the same type as that of the original affection, also develop in distant organs, as the lungs, liver, kidneys, brain, bones, pleura, and peritoneum. This dissemination of sarcoma takes place, as a rule, through the blood, either by the passage of infecting juices, germs, or cells into the vessels, or by embolism, and very rarely by the lymphatics. The lymphatic glands are either not affected at all, or they become involved very late in the disease; and the lymphatic vessels themselves are seldom occupied by sarcomatous cells. This immunity of the lymphatic system is peculiar, and serves to distinguish this class of tumors from carcinoma. The most distant organs, as, for example, the lungs, in osseous sarcoma of the extremities, are frequently involved, without the intervening lymphatic glands being at all affected.

From the preceding general description of the clinical progress of sarcomas it is evident that they bear a certain resemblance to carcinomas, but differ from them in the following particulars. After extirpation, they almost certainly return, representing the peculiarities of the original tumor, in or near the cicatrice, and this local recurrence is constantly repeated. In carcinomas, on the other hand, continuous recurrence usually is the rule. Sarcomas evince little disposition to open; they rarely give rise to a true cachexia; are almost painless before ulceration sets in; and the neighboring lymphatic glands are singularly free from implication. These distinctive features are reversed in carcinoma. To the naked eye, the only differential characteristics, so far as we are aware, are that the former are frequently incapsuled, fat is never seen in their interior, and they do not contain a juice like that of carcinoma, which can be expressed from an alveolar structure. The anatomical distinctions are not less marked, the relation borne by the cell to the intercellular substance being decisive of the nature of the mass. In carcinoma, alveoli are formed between the trabeculæ of the fibrous stroma, which are crowded by cells of an epithelial type. In sarcoma, on the other hand, the cells are arranged as parenchymatous cells, forming component parts of a continuous tissue; and the structure is never, in the true sense of the term, alveolar, in such a way that the cell elements, which always preserve the type of connective-tissue cells, are loosely grouped in the particular meshes of a stroma.

The tendency exhibited by sarcomas to local recurrence and general diffusion warrants the surgeon in regarding them as malignant formations, thereby rendering the prognosis in the highest degree unfavorable. This is particularly true of the soft varieties which are rich in small cells, whether round, fusiform, or stellate, with an abundant intercellular substance, and they include the greater number of those tumors known as medullary and hematoid fungus. They soften, and ulcerate early, bleed easily, and rapidly disseminate themselves throughout the organism. As a rule, local and general infection commence soon, and exist, although inappreciable to the eye and touch, at the time of operative interference, on which account rapid repullulation is witnessed. In these cases the prognosis, before operation, must, of necessity, be guarded, inasmuch as an important element, which guides the surgeon in carcinoma, namely, involvement of the lymphatic glands, is generally absent. The diffused forms are more infectious than those which are isolated or incapsulated, and the firm sarcomas are more benign and pursue a less rapid course than the soft. It is, moreover, important to remember that, at an early period of their development, particularly if their growth has been tardy, they are local, relatively benign affections, attended neither with pain, inconvenience, nor detriment to the general health, and amenable to operation, good results being occasionally obtained after amputation even in large osseous sarcomas of the extremities.

The degree of malignity of sarcomas differs, although it is not easy to establish the gradation. In general, however, it may be stated that soft tumors which are rich in small cells are more destructive to the part, as well as to life, than those with large cells, medullary giant-celled and colossal spindle-celled sarcomas even affording a comparatively favorable prognosis. Fibrous sarcomas are usually solitary, and, hence, are more benign

than the former. Glious, myxomatous, and pigmented tumors, with small cells, on the other hand, do not yield to carcinoma in respect to malignity. In other words, the greater the tendency to the production of more highly developed structures, as connective tissue and bone, as seen in the spindle and giant-celled sarcomas, the less grave is the prognosis; while it becomes more serious the more the tumor is formed entirely, or nearly so, of rudimental or persistent developmental tissue. In the order of malignity, the sarcomas may, therefore, be classed as follows—medullary round-celled, pigmented, alveolar, osteoid, myxomatous, lipomatous, spindle-celled, fibrous, and giant-celled. It may, however, be remarked that the prognosis is influenced by the organ or tissue affected, as well as by the structure of the tumor itself. Thus a sarcoma of the testicle is more malignant than the same variety affecting the ovary. Sarcoma of the aponeuroses gives a favorable prognosis, while in some of the mucous membranes local and distant infection rapidly supervenes.

DIFFERENT FORMS OF SARCOMA.

1. *Round-celled Sarcoma.*—Round-celled sarcoma, known also as the embryoplastic tumor, or soft, medullary, granulation, glious, lymphadenoid, or encephaloid sarcoma, is most frequently met with in young persons, and during infancy, in connection with the periosteum and the neuroglia, or delicate supporting reticulum of the retina and nervous centres. It is, however, not uncommonly observed in the skin, subcutaneous and deep connective tissues, bones, muscles, testicles, and glands, especially the lymphatic and mammary, and must be regarded as the most malignant of all growths, not carcinomatous, as it runs a very rapid course, attains huge proportions, soon ulcerates, bleeds easily, almost always, if not invariably, returns after extirpation, and possesses great powers of general dissemination, the lungs being then, apparently, its favorite seat.

On section, the cut surfaces are occasionally so soft and white as to resemble brain matter; but they usually have a translucent, light-grayish appearance, which may be tinted of a pinkish or yellowish hue, or be variously mottled by extravasated blood and injected vessels, which are very numerous and of a large size. They also furnish, on pressure or scraping, a transparent fluid, altogether different from the so-called cancer-juice. This is a peculiarity not met with in the other varieties of sarcoma, excepting the soft spindle-celled. From their naked-eye appearances, as well as from their clinical history, these growths are constantly mistaken for

Fig. 36.

Minute Structure of Lymphadenoid Sarcoma.

encephaloid carcinoma, and the difficulty of distinction between them is sometimes very great, if not insurmountable, without the aid of the microscope. In its minute structure, round-celled sarcoma is composed essentially of delicate bloodvessels and spherical, fragile cells, provided with a round or oval nucleus, and of the dimensions of lymph corpuscles, and contained in a homogeneous, dimly granular, or amorphous matrix, thereby bearing a great resemblance to granulation tissue. There are several varieties of round-celled sarcoma, which are based upon the nature of the intercellular substance, and upon certain degenerations.

a. Lymphadenoid sarcoma.—The lymphatic gland-like round-celled sarcoma is distinguished by a delicate reticulum similar to that of adenoid tissue, pervaded by large, thin-walled capillaries, which are formed of only one cell layer, as is shown at *a*, fig. 36, from Rindfleisch. The spaces between the vessels are occupied by the reticulum, the meshes of which contain lymphoid cells, with relatively large nuclei, each of which includes from one to three nucleoli, as shown at *b*. This variety of tumor is very soft, and is found more particularly in the superficial and deep-seated connective tissue of the thigh, and the periosteum and medulla of bones.

β. Glioma.—Glious sarcoma proceeds from the neuroglia, or cementing substance of the central nervous system, and is essentially composed of small round cells imbedded in a granular matrix. It differs from all other tumors of this class in being seated only in the brain, spinal cord, and the soft nerves which proceed from the brain, as the optic and its

retinal expansion, the trigeminal, and the auditory. Virchow teaches that the nervous elements which normally exist in the neuroglia, disappear in these growths, but Klebs has conclusively shown that in their earlier stages they contain ganglion cells and medullated nerve fibres, on which account he terms them neurogliomas. However this may be, glioma frequently has a soft cerebriform section, infiltrates the adjacent tissues, and occasionally reproduces itself in the internal organs. It is most frequent in infancy and early childhood in the retina.

γ. Alveolar sarcoma.—A still wider departure from the ordinary type is observed in the tumors originally described by Billroth as alveolar sarcoma, an illustration of the minute appearances of which is afforded by fig. 37, copied from that author. Roundish heaps of comparatively large cells, which look not unlike giant cells, are contained in the spaces of a connective-tissue meshwork, the coarser trabeculæ of which give off delicate bands that intersect the masses of cells and divide the larger clusters into smaller ones. It is this peculiar arrangement of the intercellular substance, along with the lymphoid character of the cells,

Fig. 37.

Minute Structure of Alveolar Sarcoma.

which serves to distinguish this neoplasm from carcinoma, as well as to exclude the term sarcomatous carcinoma, which Rindfleisch has applied to it.

Alveolar sarcoma is an uncommon, but a highly vascular growth, and constitutes a certain proportion of the so-called aneurisms of bone. It is met with in the bones, muscles, and skin; and it is as malignant as carcinoma.

δ. Lipomatous sarcoma.—The lipomatous sarcoma is not a rare form of the medullary round-celled sarcoma, in which a limited number of the cells are distended with drops of oil without being destroyed, thereby giving rise to an irregular infiltration of the mass. Its favorite seat is the subcutaneous connective tissue of the extremities, where it forms large tumors, which may be confounded with encephaloid carcinoma, but from which they may be easily distinguished with the aid of the microscope. Lipomatous sarcoma returns, as such, after extirpation, rapidly infects the neighboring lymphatic glands, and disseminates itself throughout the organism; the secondary deposits, however, retaining the type of the medullary round-celled sarcoma.

ε. Myxomatous sarcoma.—The myxomatous sarcoma is an outgrowth of early and extensive mucous transformation of the round-celled sarcoma, and derives its name from the peculiar tremulous, gelatinous appearance presented on section. It is very decidedly malignant, grows rapidly, and acquires a large volume, particularly when fatty infiltration is combined with the mucous change. These characters, when considered in connection with its infecting powers and its minute structure, serve to distinguish it from the ordinary myxomatous tumor. It has been observed in the omentum, the back, the skin, and the connective tissue of the extremities.

2. *Spindle-celled Sarcoma.*—Spindle-celled sarcoma has various synonymes, of which the most common are fibroplastic tumor and recurring fibroid, although it is also designated as fasciculated sarcoma, albuminoid sarcoma, and plasmoma. It is met with chiefly in certain growths of cicatrices and of the skin, known as keloid, and seems to have a predilection for aponeuroses, the sheaths of bloodvessels and nerves, and the subcutaneous and intermuscular connective tissues of the extremities and the neck. It is also found in periosteum, bone, the testicle, female breast, and uterus, and differs from the preceding variety in exhibiting rather a proneness to local recurrence than to general infection. In one of my cases, the growth was removed four times in ten years, and instances are on record, in which the disease, appearing primarily in young adults, has returned and been extirpated, at or near the site of the first operation, as often as five or six times, at considerable intervals, and yet the patient attained a good old age.

The most interesting and extraordinary example of recurrence, probably, ever recorded,

is one which has been for upwards of ten years under my personal observation, and which was described in former editions as encephaloid carcinoma. Reëxamination, however, proved it to be composed of sarcomatous cells, in which the small spindle forms preponderated. The patient, an unmarried woman, aged forty-four, in March, 1857, perceived in the left breast a small tumor, which was excised the following October. During the next sixteen months two more operations were performed, but as the mammary gland had only been partially removed, I extirpated the whole of it, along with a fourth tumor, in May, 1859, when the case was placed under my charge by Dr. Russell, of this city. The disease soon reappeared in the cicatrice, and in three months and a half again required the use of the knife. After four operations by myself, the case fell into the hands of one of my former clinical assistants, Dr. Asch, who attended her until May, 1861, when she was again put under my care. In September of that year, I performed the twenty-third and last operation. The number of tumors removed, from first to last, was fifty-two, varying in size from a small almond to a pullet's egg. They generally recurred at or near the cicatrice within a few weeks after extirpation, and speedily assumed a fungating appearance. They were of a soft, vascular, brain-like structure, and the seat of a thin, fetid discharge, with little or no disposition to bleed. Occasionally the woman complained of sharp, shooting pains in the tumors, extending to the shoulder, but the local suffering was commonly very slight. Her general health was all along excellent; there was no lymphatic involvement in the axilla or elsewhere; menstruation was going on well; and she always rapidly recovered from the effects of the use of the knife.

Ten years have now elapsed since the last operation. The cicatrices are all in a sound condition, very soft, and of a whitish aspect. Large portions of the pectoral and also of the external and internal intercostal muscles, were cut away, so that during a deep inspiration there is a slight protrusion of the pleura. The apex of the heart is likewise partially uncovered. It is proper to add that eleven of the operations were performed in 1860, and six in 1861.

In its earlier stages, when cut, the spindle-celled sarcoma grates under the knife, and the surface exhibts a firm, tough, grayish, or pale yellowish appearance, similar to that of an ordinary fibrous growth. After repeated repullulation and removal, however, it becomes softer, more succulent and brain-like, and it may be accepted as a rule that entirely medullary, glistening-white tumors are composed of spindle-cells, which, however, rarely attain great size. Its texture is sometimes remarkably brittle, the slightest trac-

Fig. 39.

Fig. 38.

Minute Structure of Small Spindle-celled Sarcoma.

Minute Structure of Large Spindle-celled Sarcoma

tion separating it into numerous fragments, some of which are apt to be left behind during extirpation, unless great care is used in tracing them out.

Spindle-celled sarcoma, as seen in fig. 38, from Green, and in fig. 39, from Virchow, consists essentially of fusiform cells, with well-marked nuclei, and thin processes, sometimes split at the end, and often many times the length of the body of the cell. They may be closely aggregated, forming long bands, which give a trabeculated appearance to certain portions of the growth, or they may be arranged loosely in a radiating manner. The cells are imbedded in a granular, hyaline, or fibrillated intercellular material, which usually exists in small quantity.

The varieties of spindle-celled sarcoma are the fibrous and melanotic or pigmented.

a. Fibrous sarcoma.—The fibrous sarcoma is a variety of the fibrous tumor, from which, however, it differs in the relatively greater richness and development of its cell elements, and it includes those cases of so-called fibroma, which manifest a peculiar tendency to local return, and are occasionally followed by secondary deposits, particularly in the lungs and pleura. Tumors which possess these clinical features, and show, on minute examination, segments of pure sarcomatous cells, and segments of pure fibrous tissue, should be classed under this head. In such cases, either an old fibrous tumor takes on active growth through increase of its cell elements, or a fibroma with relatively less cell development recedes and approaches more and more the type of pure sarcoma. These growths arise chiefly from the fasciæ and periosteum, and are most frequently observed in connection with the nares and base of the skull and the superior maxillary sinus.

β. Pigmented sarcoma.—Pigmented or melanotic sarcoma, although pigmentation of the cells may be met with in any of the forms of sarcoma, is usually a variety of the spindle-celled tumor, in which the cells are more or less highly impregnated with melanin,

Fig. 40.

Minute Structure of Pig-
mented Sarcoma.

as in fig. 40, from Green. To the naked eye, it has either a uniformly dark-brown or black appearance, or it may be mottled, or present limited zones of pigmentation, the intermediate portions being white, gray, or translucent. From the cut surfaces a dark, creamy juice can be scraped, which, under the microscope, exhibits round and fusiform cells in different stages of infiltration, the structure of the tumor itself being composed generally of round cells lying in the interstices of a spindle-celled network, although a pure round-celled, or a pure spindle-celled, growth is occasionally met with. The most frequent seats of pigmented

sarcoma are the skin and choroid coat of the eye, but it sometimes arises primarily in the lymphatic glands. Its great malignity is shown by its tendency to rapid and almost universal dissemination, every organ and tissue being liable to be invaded by it. In this respect, it bears a striking similarity to melanotic carcinoma, from which, indeed, it is almost impossible to distinguish it. Both are of a medullary nature ; the latter contains, as a rule, few large cells of an epithelial type, and its alveolar structure disappears very early, the cell development soon predominating over the formation of a fibrous stroma. When the structure is spindle-celled, the distinction is readily made ; but when the tumor is round-celled, it is extremely difficult to discriminate between them. The occurrence of lymphatic involvement, however, may be of some value in forming a differential diagnosis. This, as has already been pointed out, is comparatively rare in sarcoma, and very common in carcinoma. Of 83 cases of melanosis, collected by Eiselt and Pemberton, in only 33 was there contamination of the lymphatic system, a circumstance rather in favor of the majority not being carcinomatous. These facts, however, show that pigmented sarcoma is probably of more frequent occurrence than has generally been supposed, and they entitle it to a place in the varieties of sarcoma.

3. *Giant-celled Sarcoma.*—This term is applied by Virchow to that variety of sarcoma in which giant or multinucleated cells form a regular and constant element, although it had previously been described by Lebert and Nélaton as the myeloplaxic tumor, and by Paget as the myeloid or marrow-like tumor. It has been noticed in the different parts of the body, but in particular in or upon bones, the jaw-bones and the epiphyses of the long bones being its favorite seats. It has also been observed in the mammary gland, uterus, cerebral membranes, the subcutaneous connective tissue, in the muscles, and in the eyelids and conjunctiva, occurring in various sized masses, generally of a rounded or ovoidal shape, and of a consistence varying from that of tallow or suet to that of fibrous tissue. The cut surface has a smooth, compact, shining, grayish-white or greenish appearance, with blotches of a dark crimson, brownish, pink, or modena hue, either uniformly, or in various degrees of combination, all these tints being sometimes commingled. Much stress is laid upon these colors by pathologists as diagnostic characters of giant-celled sarcomas, affording, as they do, the most ready external means of discrimination between them and analogous growths. When the disease is developed in the cancellous tissue of the bones, in which its occurrence is more frequent than anywhere else, the tumor disparts the compact layers, forming a kind of cyst-like expansion, in which the new matter is lodged, and which, under such circumstances, often contains a large amount of osseous substance, soft, cellulated, of a reddish or pale yellowish tint, and easily recognized by sight and touch.

The giant-celled sarcoma is generally rapid in its growth, and is not always a benign affection. It destroys effectually the structures in which it is developed, recurs locally after extirpation, and sometimes gives rise to metastatic nodules in the internal organs. It is, however, the least malignant of the sarcomas, and the prognosis is, as a rule, favorable.

The most characteristic minute feature of this tumor, as seen in fig. 41, from Lücke, is the preponderance of multinucleated, myeloplaxic, or giant cells, which never, however, exist alone, but

Fig. 41.

Minute Structure of Giant-celled Sarcoma.

are variously intermingled with round or spindle forms, and contained in a sparse, generally amorphous, sometimes fibrillated, intercellular substance.

In addition to the foregoing three principal forms of sarcoma and its varieties, there are certain other varieties, which will be described in their appropriate places under the heads of lymphatic, cartilaginous, and osseous tumors.

The diagnosis of sarcomas during life is by no means always easy. Their form is usually well defined, round, oval, or spherical, and their surface is more or less lobulated. Periosteal tumors of this description, however, may be distinguished by their smooth surface and fusiform outline. In consistence, they may be firm, tense, and elastic, but are generally soft and apparently fluctuating, so much so, indeed, that they may be mistaken for abscesses and the softer varieties of fatty and mucous tumors. The overlying integument may be unchanged, or it may be tense, florid, or livid, and, in some parts, ulcerated, the sore, in the latter event, being usually superficial and covered with healthy-looking granulations. The subcutaneous veins rarely attain any considerable volume. Their origin is commonly traceable to external injury. They sometimes grow slowly, at other times rapidly. In the case of a lady, thirty-five years of age, whom I saw with Dr. Addinell Hewson, a small, round-celled tumor of this kind in the mammary gland attained, in the course of four months from the time of its first appearance, a weight of nearly six pounds and a volume equal to an ordinary adult head. No pain attends these neoplasms until ulceration sets in, and even then it is often very insignificant. They are most frequent between the twentieth and fortieth years, rare before and after these periods, and very uncommon in young children. In a word, a very rapidly growing, large, painless, apparently fluctuating tumor, occurring before the fortieth year, not marked by lymphatic involvement, disposition to ulcerate, or impairment of the general health, may be pronounced to be sarcomatous.

In the treatment of these tumors nothing need to be expected from general measures, the only remedy that holds out the slightest prospect for a cure being early and complete excision, with, perhaps, destructive cauterization of the surrounding parts. For the very large, soft sarcomas which originate deep in the extremities, whether from the interstitial muscular tissue, lymphatic glands, aponeuroses, sheaths of vessels and nerves, periosteum, or bone, amputation, if possible, in the contiguity of the limb, is the proper resource, while resection may be practised when the shorter bones, such as the phalanges of the fingers, clavicle, radius, and ulna, are affected. When the jaws are the seat of the disease, total extirpation is preferable to partial excision.

2. MYXOMATOUS TUMORS.

The morbid product, originally described by J. Müller under the name of collonema, is now generally known as the mucous tumor, or myxoma, from the fact that it is essentially composed of mucous material, which thus imparts to it its distinctive features. In some pathological treatises it figures as a variety of sarcoma with the prefix "gelatinous" or "net-celled." Its characteristic mucous constituent is represented in the normal state by the jelly-like matter of the umbilical cord, by the subcutaneous connective tissue of the fœtus, and to a slight extent by the vitreous humor of the adult eye. A young myxoma
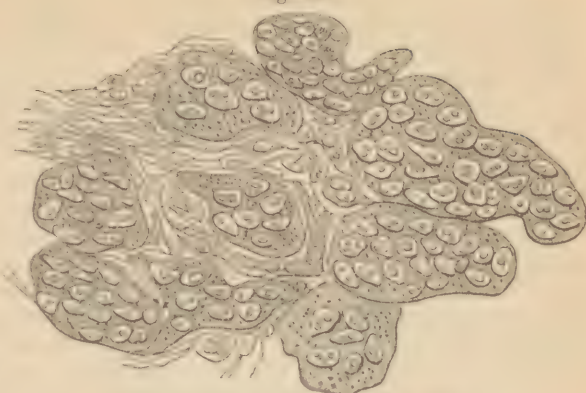
closely resembles, in its physical properties, a mass of fat; and cases are met with in which the one is directly convertible into the other by an increase or decrease of the respective constituent elements.

The characteristic features of the myxoma are elasticity and softness. Its consistence, however, is by means uniform. Occasionally the whole mass has a tremulous, jelly-like look and feel; sometimes it has an infiltrated, œdematous appearance, and readily pits on pressure; and now and then it fluctuates like a cyst. In rare cases these various properties are associated in the same specimen. The older growths are always harder than the recent, the former generally containing more solid matter and the latter more mucous.

Two essential elements enter into the composition of a myxoma, a fibrous basement structure and an intercellular substance, pervaded by bloodvessels, generally so distinct as to be easily recognized by the naked eye. The basement structure, the proper stroma of the tumor, belongs essentially to the developmental series of connective tissues, and yields on pressure, when cut, an intercellular substance of a glutinous, tenacious consistence, like the white of an egg, or a solution of gum arabic, perfectly free from milky juice. The fluid thus obtained exhibits under the microscope numerous cells, of varying forms and sizes, for the most part round, angular, stellate, spindle-shaped, or net-like. Many of the cells are of great length, as if they were beaten out, with very thin, tapering extremities. Some of the cells have several nuclei, others only one, and many of them are connected in such a manner as to present an appearance as if they were fused together.

Fig. 42.
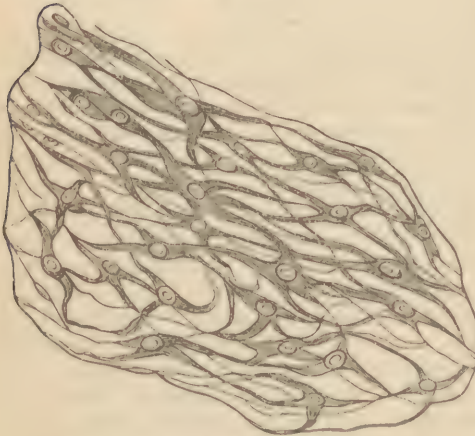
Minute Structure of a Myxomatous Tumor.

In the young myxomatous growths, abounding in mucous material, the round and angular cells are most conspicuous, whereas in the old there is a preponderance of the stellate and spindle-shaped, which not unfrequently exhibit an anastomotic and areolar arrangement, rendered very distinct on the addition of a solution of iodine or carmine, as in fig. 42, from Lücke. Besides these elements, the morbid mass often contains fat cells, fibrous tissue, both white and elastic, cartilage and bloodvessels in varying proportions, thus giving rise to certain subdivisions, as the lipomatous, fibrous, cartilaginous, and telangicetatic.

Among the more perfect types of the mucous growths are the gelatinoid polyps of the nose, ear, and uterus, and the non-malignant colloid tumors, especially those developed in the parotid region, in the nerves, and in the mammary gland. They occur chiefly in young subjects, in the subcutaneous and intermuscular connective tissues, particularly upon the thigh, back, shoulder, neck, labia, and trunk, in the mucous cavities, in the hilus of the kidney, and in the nerves and bones, in the latter of which they usually take their starting-point in the medulla. More or less mucous matter, such as distinguishes the myxoma, is often found in goitrous and other cysts, serving to impart a mixed character to the morbid growth.

The myxoma has only a very feeble circulation, and is, therefore, usually of slow growth and of small size, although occasionally the tumor advances very rapidly, and acquires a large bulk. Such an occurrence will be most likely to happen when the morbid mass abounds in embryonic material and in round cells with several nuclei. Although generally essentially benign, mucous tumors may, by their active proliferation, and their remarkable power of combining with other tumors, occasionally assume a decidedly malignant character, as evidenced by their frequent recurrence, and the formation of secondary deposits in the viscera. The latter occurrence is most frequently witnessed in the lipomatous variety, since of seven cases of which I am cognizant in only two was the tumor of a hyaline nature, while it was lipomatous in the remainder.

The myxoma is liable to hemorrhage from the accidental rupture of its vessels, but it rarely, if ever, ulcerates or mortifies. The older portions often undergo the fatty degeneration, and such portions are occasionally occupied by cartilaginous, or osseous matter, as the result of a retrogressive movement.

The diagnosis of such a growth cannot be easily solved before extirpation, except when

it occupies a mucous canal. When situated under the skin or among the muscles, its slow development, its soft, elastic consistence, its mobility, the integrity of the general health, and the absence of pain, discoloration of the skin, and involvement of the neighboring lymphatic glands may assist, but cannot positively determine, the diagnosis.

No remedies, local or general, exert any control over this variety of morbid growth. Removal is effected, according to the situation and volume of the mass, with the forceps, ligature, écraseur, or knife. Recurrence will not be likely to happen if the operation be well performed.

SECT. V.—NEOPLASMS DERIVED FROM AND COMPOSED OF HIGHER TISSUES.

1. MYOMATOUS TUMORS.

Under the term myoma may be described a tumor which is composed of muscular tissue. It embraces two varieties of growths, namely, a neoplasm containing striated muscular fibres, and a neoplasm containing smooth muscular fibres.

Fig. 43.

Minute Structure of Rhabdomyoma.

1. Myoma composed of striated or voluntary muscular fibres, or the rhabdomyoma of Zenker, is very rare, but it has been observed in the kidney, heart, uterus, testicle, in the muscles of the arm and chest, the vagina, and at the root of the nose. It consists, as is seen in fig. 43, from Rudnewa, of striated fusiform cells, with a varying amount of connective tissue. It is frequently congenital; may attain the volume of an adult head; is now and then combined with sarcoma or myxoma; and is liable to recur after extirpation.

2. Myoma composed of smooth muscular fibres, or the leiomyoma of Zenker, finds its characteristic type in the uterus. In structure, as seen in the adjoining sketch, fig. 44, from Arnott, it is made up of parallel or interlacing bundles of unstriped muscular fibres, or of elongated spindle cells with rod-shaped nuclei united by connective tissue. A few fat cells are shown in the illustration.

Leiomyoma occurs almost exclusively in the involuntary muscles, those of animal life being in great degree exempt from it. Although it is occasionally met with in the œsophagus, prostate, vagina, bladder, testicle, stomach, intestine, skin of the scrotum and mammary region,

Fig. 44.

Minute Structure of Leiomyoma.

its favorite seat is the uterus, especially the body of that organ, for the reason, apparently, that this part is much more abundantly supplied with muscular fibres than the cervix. In the organ in question it occurs in three distinct situations, as an intramural, intraparietal,

or extramural growth, capable in all of attaining an enormous bulk, cases having been observed in which the weight nearly equalled that of the body of the patient. When such a growth is developed in the cavity of the uterus, it is generally described as a polyp, although its structure does not differ from that of a myoma in the other situations referred to. In shape the tumor is, for the most part, globular, conical, or pyriform, its attachment being either by a broad base, or, as is most commonly the case, by a comparatively narrow pedicle, especially when the growth is of the polypoid variety.

The number of muscular tumors is variable. In the uterus it is often considerable, especially in the extramural variety, in which there are occasionally as many as half a dozen, or even more. In their color they are light-grayish, pale-reddish, or almost white. Their consistence varies with their age and other circumstances. Young growths of this kind are often quite soft, succulent, and even slightly elastic, whereas the older ones are very firm and dense, creaking under the knife, and tearing with great difficulty. Many, especially the older ones, contain a large proportion of fibrous matter, and, hence, such growths are usually called fibro-myomas, or fibro-muscular tumors. Calcareous matter and cysts, filled with different kinds of fluids, are also occasionally found in them; and many, as they advance in age, undergo the fatty degeneration.

A myoma is occasionally met with in the prostate gland, chiefly of elderly subjects, as an outgrowth of the normal muscular fibres, which are prolonged upon the organ from the muscular coat of the bladder. A very large proportion of the structure of this gland is, as is well known, made up of these prolongations, interspersed with the peculiar glandular substance from which the organ derives its distinctive features. The part of the gland most liable to this growth is the posterior and middle, where it occurs in various forms and degrees, constituting what is called the middle lobe, a structure which has no existence in the normal state. Small nodules of this kind are occasionally imbedded in the main body of the gland, inclosed in a distinct capsule, and easily enucleated.

The myomatous tumor is most common in advanced age. In the uterus it seldom appears before middle life, and is most frequent in elderly subjects. It is never congenital. It is generally tardy in its development, has a very scanty supply of bloodvessels, and incommodes chiefly by its weight and bulk, and by its encroachment upon the surrounding parts. In the cavity of the uterus it usually gives rise to hemorrhage, and in the prostate gland to serious obstacle to the passage of the urine.

Of the causes of these formations nothing whatever is known. Inflammatory irritation may possibly have some agency in their production, but in what manner or degree, is wholly conjectural. That they are merely so many benign outgrowths or hyperplasias of the normal tissues of the organs in which they are developed, is sufficiently evident.

Medication exerts no influence upon the progress and ultimate fate of this morbid growth. When seated in the cavity of the uterus, it is often susceptible of removal, particularly when it has a narrow pedicle, with the forceps, ligature, or écraseur. Occasionally a tumor of this kind may be enucleated; and now and then a case occurs of spontaneous expulsion, especially when the growth has undergone calcification, or when it has been partially devitalized by incisions and the injection of irritating fluids. Myomas of the prostate are irremediable.

2. VASCULAR TUMORS.

The vascular tumor, angioma, or erectile tumor, essentially consists, as the name implies, of a network of small vessels, mostly of new formation, and held together by a minute quantity of connective tissue. Its characteristic type is found in what is called a mother's mark, nævus maternus, capillary angioma, or telangiectasis, a term much employed by German pathologists, and literally signifying a dilatation of the capillary vessels. Aneurism by anastomosis, so graphically described by John Bell, early in the present century, is a not uncommon form of vascular tumor. The term erectile, as applied to these morbid growths, is, in the main, well chosen, as their structure bears, in many instances, if not generally, a very close resemblance to the cavernous body of the penis and similar erectile textures, expanding under mental emotion and whatever has a tendency to cause a temporary influx of blood.

The vascular tumor is generally met with as a congenital affection, its foundation being laid during fœtal life, and it is not uncommon for it to acquire a considerable bulk before birth. Most generally, however, it is very diminutive when first noticed, not exceeding, it may be, the volume of a pin's head, a millet seed, or a currant, and it often continues so until some time after, when, perhaps suddenly, and without any assignable cause, it

takes a new start, growing with remarkable rapidity, and encroaching more or less seriously upon the surrounding structures. The ordinary sites of angioma are the skin and mucous membranes, especially about the head, face, eyelids, lips, cheeks, and tongue. An internal hemorrhoidal tumor is essentially an erectile angioma.

Vascular tumors vary much in their color, the chief influencing causes being their structure and situation. The venous are usually of a bluish, deep lilac, claret, or purple hue, whereas the arterial are generally of a bright rose or scarlet color, in consonance with the nature of their contents. The color, however, is not always uniform, but often varies in different portions of the same growth. In their consistence they are soft and spongy, easily compressed, and often notably elastic, especially when of large bulk, of long standing, or deeply seated. An arterial angioma—the true anastomotic aneurism—always pulsates synchronously with the heart, and, as already stated, greatly augments in bulk under mental excitement; but it rarely has any of the sounds so characteristic of a common aneurism.

Fig. 45.

Vascular Tumor of the Scalp.

There is generally only one such tumor; but we often meet with several in the same patient, and in some of my cases the number was so great as to lead to a belief in the existence of a kind of angeiomatous diathesis.

Although most vascular tumors are congenital, they occasionally do not make their appearance until a long time after birth. How far external injury, as a blow or bruise, may be instrumental in giving rise to such formations is undetermined. There are, however, numerous instances upon record which go to show that it may act as an exciting cause. In a case related by the late Dr. J. Mason Warren, a man, thirty-six years old, had a large aneurism by anastomosis on the lobe of one of his ears, consequent, apparently, upon a severe frost-bite, received at the age of sixteen.

Fig. 46.

Minute Structure of Simple Angioma.

Fig. 47.
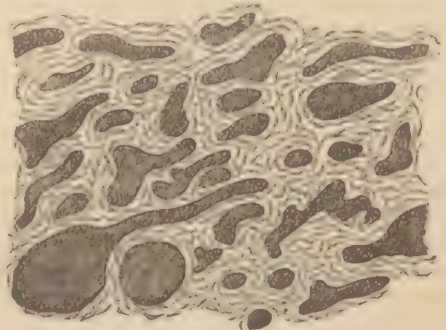
Minute Structure of Cavernous Angioma.

The vascular tumor exhibits considerable variety of structure, being at one time essentially composed of veins, at another of arteries, and occasionally, again, of both arte-

ries and veins, so equally balanced, in number and calibre, as to render it difficult, if not impossible, to determine which predominate. In the simple angioma, which embraces the various forms of telangiectasis and nævi, the vessels, arterial, venous, or capillary, are greatly enlarged, tortuous, and anastomose, as in fig. 46, from Billroth. In the cavernous angioma, or cavernous venous tumor, which comprises erectile tumors and aneurism by anastomosis, the structure, as displayed in fig. 47, from Rindfleisch, is very similar to the cavernous body of the penis, being composed of a reticulated meshwork of dense and elastic connective tissue, lined by endothelium, and distended with blood. The meshes or alveoli freely intercommunicate, and constitute a system of cavities in which the blood carried to them by numerous vessels circulates. Old angiomas sometimes contain phlebolites and organized clots. Numerous instances are recorded in which the patient bled to death in attempts to extirpate such tumors.

The diagnosis of angiomas is deduced from their situation, color, and consistence, and from a careful consideration of the history of the case. The prognosis varies. The venous tumor is always less dangerous than the arterial, which, as it enlarges, is liable, especially under the influence of injury, ill-health, or exhausting disease, to ulcerate, to bleed, and to cause absorption of the surrounding structures, the osseous and cartilaginous not excepted. Some growths of this kind, arterial as well as venous, occasionally enjoy a period of repose, apparently neither advancing nor receding; generally, however, the reverse is the case, there being a disposition to rapid development, the more especially when there is a marked predominance of the arterial element, or when the tumor is almost exclusively composed of this structure. A spontaneous cure occasionally occurs, the vessels becoming obliterated, probably as an effect of inflammation leading to the coagulation of their contents and the gradual closure of their calibre. Recurrence has been witnessed after excision, probably due to the imperfect use of the knife rather than to any inherent tendency to repullulation. Carcinomatous or sarcomatous degeneration is possible, but very uncommon. The treatment of angiomas will be fully discussed in the chapter on the affections of the capillary vessels.

3. LYMPHANGIOMATOUS TUMORS.

Tumors composed of newly-formed and of dilated preëxisting lymph vessels are uncommon, but their existence is confirmed by a number of examples which have been recorded during the past fifteen years, and which have been carefully studied by Wegner in an elaborate paper published in the Archiv für Klinische Chirurgie for 1877.

Lymphangioma may be simple, cavernous, or cystoid. The simple variety consists of an anastomosing network of lymphatics supported by a slight quantity of connective tissue, so that it resembles simple or plexiform angioma. Cavernous lymphangioma is composed of a trabecular cavernous tissue, the meshes of which are filled with fluid or thrombosed lymph. Hence it has the same anatomical construction as cavernous angioma or venous tumor, the only difference being that its meshes contain lymph instead of blood. The cystoid variety, as the term implies, is characterized by the presence of one or more cysts, which usually arise from the occlusion of the openings of communication between the meshes of the cavernous variety and the efferent lymph vessels. Of the three divisions, the cavernous is the one usually met with.

The most common sites of lymphangioma are the neck, where it forms a certain proportion of the congenital cystic hygromas, the tongue, the lips, and the cheeks, in which it is known, respectively, as macroglossia, macrochilia, and macromelia, the groin, and the perineum. It has also been observed on the forehead, in the axilla, the mammary region, the shoulder, the buttocks, the penis, the adrenal, the kidney, the liver, and the mesentery. In all of these situations its point of departure is the superficial or deep connective tissue. The tumor may be diffused, as when it occurs in the tongue, the lips, or the cheeks, or it may be distinctly circumscribed, and even be surrounded by a well-formed capsule.

The etiology of lymphangioma is obscure. Although it may be acquired, and is occasionally ascribable to injury, it is nearly always congenital. Its growth is constant, but, as a rule, very gradual, so that many years may elapse before it attains the volume of a walnut. Now and then its increase is so very rapid that it may attain the size of a fist in six or eight weeks, or, in the course of fifteen or eighteen months, even of a child's head.

When it involves the tongue or the lip, the neoplasm is of a fibro-elastic consistence, but in other situations it is soft and compressible like myxoma, or even fluctuating, as when

it is of the cystoid variety. It is rarely painful, and it evinces no tendency to ulcerate; but it is liable to attacks of inflammation, during which it increases in volume, becomes hot, red, and tender, and gives rise to constitutional disturbance. The integument covering the growth is now and then the seat of small, transparent vesicles, which, on bursting, admit of the escape of its contents.

In the absence of lymphorrhœa and periodical attacks of inflammation, these tumors so closely resemble the soft fibromas, lipomas, myxomas, and simple angiomas, that their discrimination is most difficult before removal. The cavernous and cystic varieties may, however, be readily recognized by the exploring needle, the withdrawal of which is attended by the escape of colorless fluid presenting the chemical and physical properties of lymph.

Lymphangiomas are benign formations. The proper treatment is by excision; but the knife should be replaced by irritating injections when the cystoid variety is situated in the midst of important structures, as, for example, in the neck.

4. NEUROMATOUS TUMORS.

The nerves of animal life, especially the radial, ulnar, median, tibial, and peroneal, are subject to two forms of tumors, known, respectively, as the true and spurious neuroma, the former being composed principally of nerve substance, while the latter is seated on and in the nerve trunks, and includes fibromas, sarcomas, and myxomas, as well as the painful tubercle, incidentally noticed by Petit, Cheselden, Dupuytren, and other observers, and first accurately described, in 1812, by Mr. William Wood, of England. The neuromatous tumor, properly so termed, has been particularly studied and delineated by Mr. Robert W. Smith, of Dublin, who published a splendid monograph upon it in 1849.

A true neuroma may arise in the gray centres of the brain and spinal cord, but it is very uncommon in these situations, and is of no clinical importance. The form which chiefly interests the surgeon proceeds from the peripheral nerves, and is composed of nerve fibres, partly of new formation, and partly of preëxisting hypertrophied fibres, separated by connective tissue. It may contain medullated fibres, when it is denominated

Fig. 48.
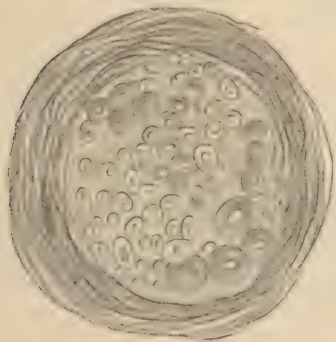
Minute Structure of a True Neuroma seen
in Transverse Section.

Fig. 49.
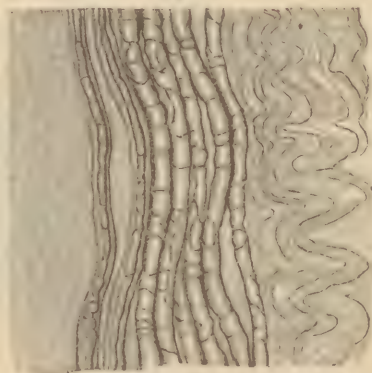
Minute Structure of a True Neuroma seen in
Longitudinal Section.

myelinic by Virchow, or non-medullated fibres, when it is known as amyelinic neuroma; but the latter variety is difficult of determination, since it is scarcely possible to distinguish the fibres of Remak from fibrous tissue. Both sets of fibres generally exist in conjunction in the same tumor, as may be perceived by a reference to figs. 48 and 49, magnified 450 diameters, after Dr. Paul Bruns, of Tübingen. The former, copied from a transverse section of a plexiform neuroma of the posterior auricular region, shows the relation of the nerve fibres to their sheaths and to the interstitial connective tissue. In the largest fibres, the concentric arrangement of the myelin around the axis cylinder is very apparent, while it is missing in others. The smallest filaments are composed of naked axis cylinder alone. The latter figure represents a longitudinal section of the same tumor, with its double-contoured or myelinic nerves, and fibrillated and wavy connective tissue. In this particular specimen, therefore, the nervous substance constitutes the greater part of the growth; but other formations are met with in which the interstitial

tissue preponderates, thereby giving rise, in accordance with the nature of the latter, to the fibrous, glious, or myxomatous varieties of neuroma.

The neuromatous tumor is commonly solitary, but there may be a considerable number, varying in size from a pea to that of an almond, an egg, or even an adult head. It is solid to the touch, firm, inelastic, and of an oblong, ovoidal, or irregularly compressed form. When small, it has generally a distinct cyst, of fibrous structure, filled with a transparent jelly-like substance, and developed within the neurilemma of the affected nerve, the filaments of which are separated from each other, and spread out over the surface of the tumor. In cases of long standing, or when the tumor is of unusual bulk, the morbid mass is remarkably dense, white or nearly so, homogeneous, and destitute of a cyst, properly so called.

The neuromatous tumor occurs in both sexes, and at various periods of life, although it is most common in males and in middle age. Its progress is usually slow, and it seldom attains any great volume. The exciting causes are generally very obscure, but in some cases it is plainly traceable to the effects of external injury, as a wound, blow, or bruise; while in other instances there is a congenital or hereditary tendency to its formation. Now and then, a veritable neuromatous diathesis exists. In such an event, nearly all the nerves of the body, central, spinal, and sympathetic, may be affected. Smith, in one instance, counted as many as eight hundred enlargements, and in another upwards of two thousand. Occasionally it follows upon amputation, the nerves of the stump becoming enlarged and bulbous. The pain which attends the disease is very variable, both in degree and in character. In most cases it is neuralgic, exceedingly severe, sharp, darting, pungent, or stinging, and liable to periodical exacerbations, dependent, apparently, upon atmospheric vicissitudes, and disorder of the digestive functions. The slightest pressure, friction, or manipulation increases the suffering, which then, not unfrequently, amounts to great agony. The parts beyond the tumor, especially those supplied by the affected nerve, are cold, numb, and almost powerless. The pain is sometimes seated in the neighborhood of the tumor rather than in the tumor itself; and occasionally again there is no local distress whatever. Although the general health may remain good, ordinarily it is more or less impaired; and the system, constantly tortured by the excessive suffering, is gradually reduced to the utmost prostration.

Fig. 50.

Neuromatous Tumor with the Nerve passing to and from it.

The accompanying sketch, fig. 50, affords an excellent illustration of the gross characters of a myxomatous neuroma of the peroneal nerve. It had existed for nearly twenty years, during the last three of which it was exquisitely tender and painful. It was extirpated by Dr. Dalton and Dr. Hoffman, of Ohio, who kindly sent me the specimen. The operation was followed by sloughing of the fourth and fifth toes.

Under the term plexiform or cirsoid neuroma, Verneuil, Billroth, Bruns, and others, have described a peculiar form of this affection, which the last author, from whom the accompanying sketch, fig. 51, is taken, includes among the true neuromas. It consists of nodular, convoluted, or varicose cords, and may be mistaken for cirsoid aneurism, from which, however, it differs in its incompressibility and freedom from pulsation. It has been observed only in seventeen instances, in all of which it was congenital, and it appears to have a predilection for the subcutaneous connective tissue of the upper lid, and temporal and cervical regions. It is singularly free from pain, but is occasionally tender on firm pressure. The affection is generally attended with hypertrophy of the overlying integument and very marked enlargement of the sebaceous follicles.

The only effectual treatment is excision. As long, however, as the tumor is painless, or causes no inconvenience, it is best to let it alone. The operation is usually very sim-

ple, and devoid of danger. An attempt should generally be made to enucleate the tumor, by pushing aside the nervous filaments, or separating them from the parts in which they are embedded. When this is impracticable, from the manner in which the structures are fused together, the mass should be exposed by a free incision, and lifted out of its bed by

Fig. 51.

True Plexiform Neuroma.

dividing the affected nerve immediately above and below, over a grooved director. The loss of motion occasioned by this proceeding, even when it involves a comparatively large nerve, is usually restored in a very short time. Indeed, the chief inconvenience to which it gives rise is a sensation of coldness in the distal part of the limb, which may, however, remain for years. Amputation has been resorted to for the cure of this complaint; but it is difficult to conceive of a case in which it would really be necessary.

The painful *subcutaneous tubercle*, fig. 52, is generally situated, as the name implies, immediately beneath the skin, in the connective tissue, or in this tissue and in the skin.

Fig. 52.

Fig. 53.

Painful Subcutaneous Tubercle.
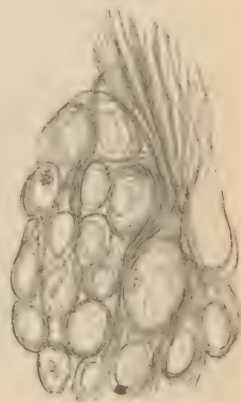
Microscopic Structure of the Subcutaneous Tubercle.

In its minute structure, as seen in fig. 53, it appears to belong to the connective tissue series, being composed of fibrous tissue either in a rudimental or perfect state. The pain which attends it would seem to establish some relation between it and the superficial nerves, and it is highly probable that amyelinic nerve fibres are involved in it. This point is, however, difficult of demonstration, as it is almost impossible to distinguish such fibres from those of fibrous tissue. In one instance, Virchow found that the tubercle was composed of gray nerve fibres. On being cut out it looks very much like a small mass of adipose substance, the section having a bright yellowish, grayish, or whitish aspect. Few vessels can be discerned in it. It is always remarkably small, seldom exceeding the volume of a pea; very movable; exquisitely tender to the touch; and the seat of frequent pain, often of a neuralgic character, and subject to constant exacerbations from the most trivial causes. It is generally represented as being most common in the lower extremities, but this does not accord with my experience, most of the cases that have come under my observation having occurred in the arm, forearm, and shoulder.

The painful tubercle is generally single, or, if multiple, more than two or three rarely exist in the same person. It occurs in both sexes, but much more frequently in women than in men, the reverse being the case in regard to the neuromatous tumor. Its development is usually tardy, and several years often elapse before it becomes very tender and painful. Women of a nervous, hysterical temperament appear to be most prone to its occurrence. During its development it always involves the skin.

The situation of this tumor just beneath the skin, or in the skin and connective tissue, the absence of discoloration of the surface, the peculiar character of the pain, the intolerance of manipulation, and the history of the case, generally suffice to determine the diagnosis.

The only remedy is free excision, including a small portion of the surrounding healthy integument. The disease never returns at the cicatrice, although it may occur afterwards in other parts of the body.

SECT. VI.—NEOPLASMS WHICH PROCEED FROM AND ARE COMPOSED ESSENTIALLY OF EPITHELIUM.

The epithelial neoplasms may be typical or atypical. The former embrace papilloma and adenoma, and the latter are confined to the carcinomatous formations.

1. PAPILLARY TUMORS.

The morbid growths comprised under this appellation have their physiological prototypes in the papillæ and villi of the cutaneous and mucous membranes from which they are generally derived; and they are composed, as is seen in fig. 54, from Rindfleisch, of vascular connective tissue, covered by epithelium, which varies in character in accordance with the origin of the formation. In some of these hyperplastic tumors, as in the ordinary wart, corn, and horn, the epithelial elements predominate; while, in others, as in the condylomas, and the villous or papillary growths of the mucous surfaces, the connective tissue forms the essential constituent.

Fig. 54.

Minute Structure of Papilloma.

Two varieties of papillomas naturally fall under this arrangement, the corneous or hard, and the mucous or soft: the former consisting of warts, corns, horns; and the latter of condylomas, certain outgrowths from the nose, larynx, the gastro-intestinal tract, the neck of the uterus, and the bladder, and the formations met with in the serous surface of the dura mater. The corneous variety is most common in the hands, fingers, toes, forehead, face, and trunk. The soft variety, on the other hand, is generally met with in the mucous canals, as the vagina, the rectum, and the nose. The excrescences which form around the anus and on the head of the penis, perineum, and vulva, as a consequence of inoculation with the venereal virus, belong to this category of morbid formations. The bladder, colon, rectum, and inside of the cheek, palate, and pharynx are occasionally the seat of villous growths, the papillary structure of which is generally recognizable by the naked eye. The very vascular, florid, sensitive tumor met with at the orifice of the female urethra, and the vascular excrescences occasionally seen in the interior of the larynx in and around the vocal cords, are well-marked examples of a similar kind. Certain tumors which occasionally project from the serous surface of the dura mater belong to the same group; and the researches of Professor Von Luschka into the minute structure of the Pacchionian bodies render it highly probable that these structures are merely enlarged villi which naturally exist upon the adherent surface of the arachnoid membrane.

Papillary tumors are frequently very vascular, and those of the mucous surfaces are not uncommonly attended with ulceration and exhausting hemorrhage. They are benign formations, but they may degenerate into carcinoma or sarcoma. Concerning their treat-

ment, no definite plan need be laid down here, as the subject will be fully discussed in connection with the different organs and structures in which they are developed.

2. ADENOMATOUS TUMORS.

The glandular tumor, or adenoma, owes its name to the peculiarity of its structure, which is a close imitation of the normal glandular tissue, whether acinous or tubular. It is essentially a hyperplastic growth, consisting of newly-formed gland tissue, corresponding in its main features with what Lebert has described under the name of "partial glandular hypertrophy," and is frequently, but incorrectly, described as adenoid tumor. Its principal seats are the parotid, thyroid, mammary, prostate, and sweat glands, and the mucous follicles of the lip, cheek, palate, nose, vulva, vagina, uterus, and rectum. In the breast the new product is either imbedded in the substance of the organ, or it projects from its surface as a peripheral outgrowth, continuous with the parent tissues by a distinct pedicle. In adenomas of the parotid and prostate glands a similar law obtains in regard to the site of the new growth.

An adenoma is, for the most part, a solitary tumor, of a firm, dense, inelastic consistence, especially in its earlier stages, of a whitish, grayish, or pale straw color, surrounded by a capsule, or limitary membrane, easily enucleated, and seldom larger than a hickory-nut, an almond, or a pullet's egg. The sectional surface has often a glistening appearance, and, in recent growths, yields no fluid on pressure. Few bloodvessels enter into this tumor. The epithelial cells which naturally line the ducts and acini of the glands commonly consist of a single layer.

Under the microscope the newly-formed glands are arranged as acini, or as tubes, as in fig. 55, from Green, separated usually by a small amount of connective tissue. The cells which line the lobules or ducts rest upon a limiting membrane, which serves to distinguish the growth from carcinoma. The best type of the acinous or lobular adenoma is that which occurs in the mammary gland. The tubular or duct adenoma proceeds from the mucous membranes, and frequently constitutes one of the varieties of mucous polyp.

In the mucous follicles, the tumor, rarely larger than a cherry, or small nut, is always, as in the mammary and prostate glands, distinctly encapsulated, while in the thyroid body, belonging to the ductless order of glands, the new glandular structure, usually even in its earlier stages, exhibits a remarkable tendency to cystic

Fig. 55.

Minute Structure of Adenoma of the Mamma.

transformation, so characteristic of goitre. All adenomas exhibit, indeed, the same tendency, which is due to mucoid softening of the proliferating epithelial cells and dilatation of the ducts. In some cases, the epithelium gives rise to vegetations or papillæ which more or less completely fill the cysts.

The period of life at which adenoma is developed varies in the different organs. In the breast it is most frequent from the age of puberty to that of thirty-five, young prolific females being its most common subjects. In the thyroid body it generally begins before the fifteenth year, especially in those parts of the world in which goitre is endemic. In the labial, buccal, vaginal, and uterine glands the occurrence is most frequent in young and middle-aged persons. In the prostate gland it is usually associated with, or a consequence of, senile hypertrophy of that organ, occurring either in its substance, or as a pedunculated, polypoid outgrowth.

In the mammary gland adenoma is frequently quite tender on pressure, and occasionally even very painful, especially in young females, the subjects of dysmenorrhœa, the suffer-

ing being then very liable to assume a neuralgic character. In most of the other organs the tumor incommodes simply by its bulk and situation, or mechanical inconvenience.

Adenoma usually arises without any assignable cause. Its progress is generally very slow, and it seldom attains any considerable volume, although when it invades an entire gland, as the mammary or parotid, it may reach a great bulk. In its character the tumor is essentially benign, but, in exceptional cases, it is no doubt, like other benign growths, capable of assuming malignancy. When thoroughly extirpated, no relapse will be likely to occur, although examples have been recorded in which as many as three, four, and even five operations were performed upon the same tumor.

Adenoma is distinguished by its locality, by its tardy and equable growth, by its circumscribed, ovoid, and bossed outline, by its firm, inelastic consistence, by its hard and heavy feel, by the absence of lymphatic involvement, and by the integrity of the general health.

In the treatment of adenomas very little is to be expected from medication, and a spontaneous cure is very uncommon. Occasionally, under favorable circumstances, dilute tincture of iodine and a weak ointment of the biniodide of mercury prove useful in promoting the absorption of the tumor. Iodide of potassium and bichloride of mercury administered internally, have sometimes been beneficial. The efficacy of such treatment is most evident in cases of recent standing and in growths of small size. Some surgeons speak favorably of methodical compression, but as this is difficult, and in many cases impossible, little advantage is to be anticipated from its employment. When the tumor is painful, as when it is the seat of neuralgia, or of large size, causing inconvenience by its weight or pressure, or when it is partially softened, the only rational remedy is extirpation. A single incision often suffices to expose the tumor and to effect its enucleation. The whole organ in which it is situated must be sacrificed when the disease pervades its entire substance; but such a procedure, for reasons previously mentioned, will seldom be necessary.

3. CARCINOMATOUS TUMORS.

Under the term carcinomatous are comprised certain morbid growths, which have the effect, within a variable period after their formation, of destroying not only the tissues in which they are located, but also the life of the patient. The formations commonly embraced under the present head are scirrhus, encephaloid, colloid, melanosis, and epithelioma. It would greatly simplify the study of these affections if the term " cancer," by which some of them continue to be designated, were altogether discarded from surgical nomenclature. This expression, introduced in the infancy of the science, is commonly employed as the substantial equivalent of malignant, and is, therefore, calculated to mislead the mind of the inquirer.

Of the extensive prevalence of carcinomatous disease some idea may be formed when it is stated that, in the five years from 1838 to 1842, inclusive, 11,662 persons died of it in England alone, independently of the cases which occurred in London. Of these cases, 8746 occurred among women, and 2916 among men, or in the ratio almost of three to one. Mr. S. W. Sibley, in 1869, analyzed 522 cases of carcinoma, collected from the records of the Middlesex Hospital, of which 419 related to females, and 103 to males. This disparity of the disease in the two sexes is due to the extraordinary frequency of carcinoma of the uterus and mamma, particularly the former, which suffers nearly as often as all the other organs together.

These various morbid formations, although widely differing in many of their characters, possess certain features in common with each other, which may be briefly enumerated before they are individually described.

1st. Microscopically considered, they are distinguished from all other neoplasms by the marked alveolar structure of their fibrous stroma, the alveoli being disorderly crowded with unadherent polymorphous cells of an epithelial type, without the intervention of formed intercellular substance.

2dly. They are always derived primarily from the epithelium of the glands, or of the skin, and mucous membranes. Instead of being confined by a limiting membrane, as occurs, for example, in adenoma of the mamma, the epithelial cells infiltrate, grow, or thrust themselves into the surrounding connective tissue, thereby giving rise to an atypical epithelial formation, or one which is entirely unlike the normal glandular structures.

3dly. They are all at the outset of a purely local character, but after a variable period of their existence they evince malignant attributes, as is indicated by their infiltrating the

adjoining tissues, by the production of similar tumors in the associated lymphatic glands, and by the formation of metastatic deposits in the various textures and organs.

4thly. They occur only, as primary affections, in the epithelial organs and tissues of the body, particularly during middle age, in persons of all temperaments, occupations, and social conditions. They occasionally display a marked hereditary tendency, and also a disposition to appear in several members of the same family.

5thly. Their progress is generally rapid, most of them causing death in from nine months to two years and a half from their commencement.

The so-called cancer cells, which, along with the creamy, homogeneous, or granular intercellular substance, form what is termed the cancer-juice, have been, and still are, a prolific source of disputation. Apart from the peculiar arrangement of the stroma, these protoplasms cannot be said to be characteristic of carcinoma, and yet the practised microscopist would not hesitate to pronounce a tumor to be of that nature, if it were composed principally or entirely of such nucleated cells as are delineated in fig. 56, from Green, Rindfleisch, and Paget, representing typical forms derived from different carcinomatous formations. At *a* are exhibited the multiform cells of scirrhus and encephaloid, which

Fig. 56.
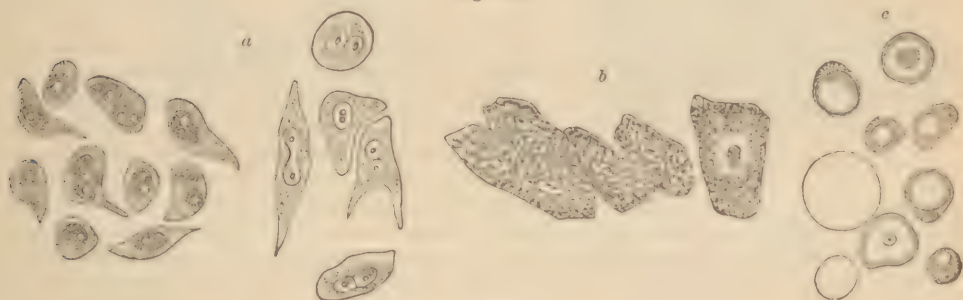
Cells of Carcinoma.

range from $\frac{1}{1500}$ to $\frac{1}{700}$ of an inch in diameter. In shape they vary greatly. Commonly oval or nearly spherical, some are pyriform, some fusiform, some angular, others reniform, and they are provided with one, and occasionally even with several large, oval, well-defined, eccentric, nucleolated nuclei. At *b* are represented the most common types of cells of epithelioma. They are generally round-oval, singly nucleated, flattened, and scale-like, and vary from $\frac{1}{1200}$ to $\frac{1}{200}$ of an inch in their chief diameter. At *c* are delineated the cells of colloid carcinoma, which consist of the vacuolated and the seal-ring forms, from $\frac{1}{500}$ to $\frac{1}{250}$ of an inch in diameter. The origin of the so-called cancer cells, the distinctive feature of which is their epithelial character, is still involved in mystery. According to Virchow, Rindfleisch, Volkmann, Cornil and Ranvier, Tripier, Coyne, and Moxon, they are developed by proliferation of the connective tissue corpuscles, a theory of formation which has been placed in doubt by the results of embryological inquiry. His, Aeby, Thiersch, Waldeyer, Billroth, Samuel, Klebs, Lücke, Langhans, and other pathologists, contend that histological researches have failed to demonstrate the derivation of the epithelial cells from corpuscles of connective tissue. Thiersch maintains that epithelioma originates from increase and multiplication of preëxisting epithelial cells alone; while Waldeyer and Billroth extend this view to all carcinomas. That epithelium must be produced from its like, and that carcinoma can only arise as a primary growth in the epithelial structures which are derived from the outer and inner layer of the embryo, are statements which I fully indorse, and I believe that the continuous proliferation and transplantation of the epithelium are sufficient to account for all the changes met with in the development and extension of carcinoma, without invoking the aid of other theories.

The stroma, or basement structure, the second essential constituent of carcinoma, consists of succulent, preëxisting connective or fibrous tissue, although it is, now and then, partly a new formation. The trabeculæ of the stroma form elongated ovoidal spaces or meshes, which freely communicate with each other, and impart to it an alveolar or cavernous appearance. The cells are packed in the alveoli, and a few lymphoid cells are usually intercalated between the fibres of the stroma itself. These appearances are well shown in fig. 57, from Rindfleisch, which exhibits a partially pencilled-out section of encephaloid, magnified 300 diameters. The stroma is variously supplied, according to the variety of the neoplasm, with bloodvessels, some of which are normal to the part,

while others are of new formation. Lymphatic vessels have been demonstrated to com-
municate with, or to open into, the alveoli, as in fig. 58, from Cornil and Ranvier, a fact
which explains the almost constant involvement of the lymphatic glands.

Carcinoma is always derived from the epithelial elements of the glands, or of the
skin and mucous membranes. Its evolution
in a glandular organ, as the mamma, can be
readily traced. Thus, the acini and ducts be-
come enlarged and deformed, and more or less
completely filled with proliferating epithelium.
The periglandular connective tissue is, at the
same time, infiltrated with lymphoid cells, out of
which the newly formed stroma is produced. Dur-
ing the second stage, the basement or limiting
membrane of the acini and ducts is broken
through, and the cells extend into the new con-
nective tissue and the preëxisting lymph spaces
as solid, branching cylinders, or plugs, whereby
the normal appearance of the mamma is com-
pletely destroyed. Some of these changes, as
well as the relation borne by the cells to the
stroma, are represented in the adjoining sketch,
fig. 59, from Rindfleisch, magnified 300 diame-
ters. At *a* the connective tissue is infiltrated
with corpuscles, the nuclei of which at first di-
vide, followed by fission of the cells and their accu-

Fig. 57.

Stroma of Carcinoma.

mulation in rows.   The young cells finally enlarge and assume various shapes, until, as
depicted at *b*, they have collected in groups in the meshes of the tissue, the fibres and
lymph spaces of which they have disparted to form elongated ovoidal spaces or alveoli.

Carcinomatous tumors are at the outset local degenerations of the tissues or organs in
which they are situated.   The marked tendency to recurrence after extirpation, to con-
tamination of the lymphatic
glands, and to the development
of secondary nodules in the
viscera, so far from being a
sign of a constitutional taint
or dyscrasia, merely shows that
the original tumor acts as a
focus of infection of adjacent
and distant parts. As they are
not surrounded by a capsule,
their growth is generally rapid,
and the increase in volume is,
for the most part, peripheral,
their constant tendency being
to infiltrate the surrounding
structures by the penetration
of young epithelial cells into
the continuous, loose connec-
tive tissue spaces. This very
interesting fact has a direct
and most important bearing
upon the results of surgical
operations performed for the
removal of malignant forma-
tions.   Schroeder Van der
Kolk, to whose researches we

Fig 58.

Carcinoma of Mammary Gland—the ground substance of the section
stained with nitrate of silver. *a*. Alveoli of the carcinoma filled with
cells. *b*. Lymph spaces shown in the fibrous tissue after treatment by ni-
trate of silver. *c*. Lymphatics showing silver staining of the endothelium.

are mainly indebted for this knowledge, states that the tissues immediately around the
morbid mass, although perfectly healthy in appearance when viewed with the naked eye,
are, if examined with the microscope, found to be infiltrated with young cells, which
gradually increase in size and number in proportion as the periphery of the tumor is ap-
proached. This fact affords a ready reason why carcinomatous growths so frequently
recur after extirpation at the site of the original disease. Fig. 60, from Billroth, magni-

fied 350 diameters, and representing cell infiltration of the fatty tissues around a carcinomatous lymphatic gland, serves to convey a good idea of these appearances.

A characteristic feature of carcinomatous growths consists in their tendency to multiply

Fig. 59.
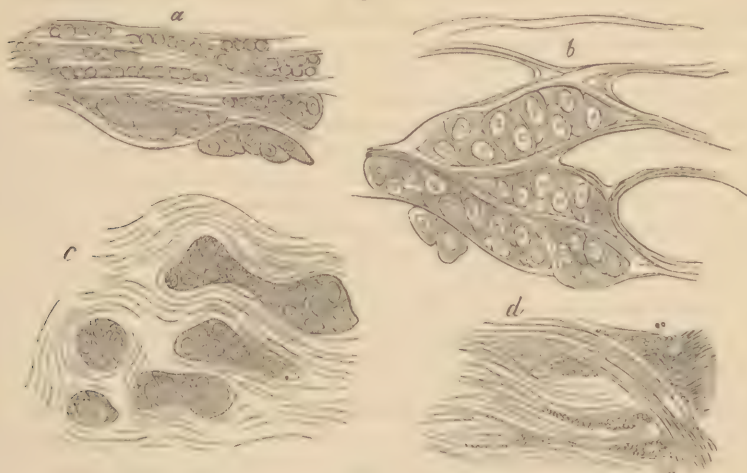
Scheme of Development of, and Retrograde changes in, Carcinoma.

and disseminate themselves, until, in many cases, a considerable number of tissues and organs are successively affected with analogous deposits. This infecting power is due to the transference of germs or juices by the veins or lymphatics, particularly the latter, as is evinced by the early and frequent invasion of the lymphatic glands and the blocking up of the vessels themselves with carcinomatous material. It is very rare to witness secondary nodules in distant organs without involvement of the intervening glands, and in this respect carcinoma, as has already been pointed out, bears a striking contrast to sarcoma.

It would be of great practical utility if we knew the origin of carcinoma, or the causes, local and constitutional, under the influence of which it is developed; but upon this subject we are, unfortunately, entirely ignorant, nor is it likely that our inquiries concerning it will lead to a satisfactory solution of a question which has occupied so much attention.

Fig. 60.

Cellular Infiltration of the Fatty Tissues around a Carcinomatous Lymphatic Gland.

Among the predisposing causes may be mentioned age and sex. Carcinoma never occurs before puberty, and is most common between forty and sixty, or during the period of functional decline of the various secreting organs. It is far more prevalent in females than in males in consequence of the extraordinary frequency of its occurrence in the uterus and mammary gland, but its evolution does not appear to be influenced by pregnancy or lactation. It is sometimes inherited; that is, it manifests a tendency to descend from parent to child; and this factor in its production is due to the transmission of a peculiarity of tissues, which renders them more prone to take on carcinomatous degeneration in some persons than in others not similarly predisposed. This tendency, however, is much less frequent than is generally supposed, since of 389 examples of carcinoma of the female breast, analyzed by Dr. S. W. Gross, only 10.30 per cent. could be assigned to hereditary influence. Besides, it should be remembered that there is a difference, and that a very wide one, between the transmissibility of this disease from the parent to the offspring, and its coexistence, or successive development, in different members of the
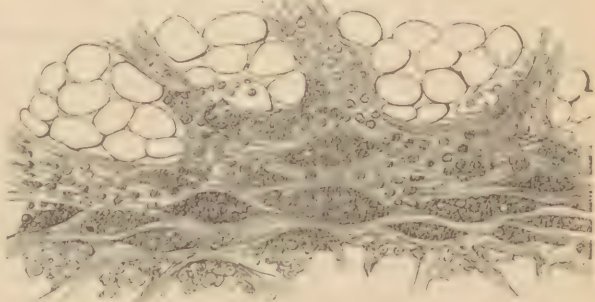
same family. The latter occurrence, although also very uncommon, is much more frequent than the former, of which my own experience has supplied me only with a few examples. Lately, I saw a well-marked carcinoma of the mammary gland in a lady whose mother and maternal aunt had died of a similar disease. In 1855, I prescribed for an aged female with a carcinoma of the lip, whose mother had perished from carcinoma of the breast, and the father from carcinoma of the tongue. One of the most remarkable and instructive instance of this kind upon record, is that related by Dr. Warren, in his work on Tumors. A man died of carcinoma of the lip; his son had a similar disease in the breast, from which, after having undergone an operation at the age of sixty, he finally lost his life. Two of his sisters had carcinoma of the mammary gland; they were operated upon, but ultimately died from a relapse of the malady. A daughter of one of the ladies had a carcinoma of the breast, which was removed at an early period; she recovered, but perished some years after, from disease of the uterus. A daughter of the gentleman had a carcinoma of the breast, and there was reason to believe that other members of the family were affected by the same malady.

A case, almost equally remarkable, of this hereditary tendency to carcinoma, was communicated to me by the late Dr. J. M. Warren. In this instance, a man who died of carcinoma of the penis, had lost his father, grandfather, and great-grandfather from similar disease. In a case, recorded by Broca, out of a family of twenty-six, in three successive generations, fifteen died of carcinoma.

More frequently, as has already been stated, the disease occurs, either simultaneously or successively, in several members of the same family. My own practice has afforded me a number of instances of this kind, and all writers on carcinoma narrate examples of it. In one remarkable case, four out of six members of one family have died of the disease; one from carcinoma of the uterus; another from carcinoma of the mammary gland; a third from a malignant polyp of the nose; and the fourth from carcinoma of the thoracic viscera. Professor Gibson gives an instance of carcinoma of the breast in four sisters. Of 322 cases of carcinoma, analyzed by Paget, the disease occurred in other members of the family in 78, or very nearly in one-fourth. In 305 cases collected from the records of the Middlesex Hospital, London, by Mr. S. W. Sibley, the disease was traced to the relatives of the patients in $8\frac{3}{4}$ per cent. of the entire number of cases. Most of these cases occurred in females.

The opinion, once so prevalent, that carcinomatous affections owe their origin to a peculiar virus, either generated within the system, or introduced from without, has long been obsolete. It is, at all events, perfectly certain that if there be such a poison, its existence has never been demonstrated. The juice of carcinoma, even when the disease is in a state of ulceration, is not inoculable, or communicable by immediate contact, as the matter of smallpox, vaccinia, chancre, or gonorrhœa. If it were, the disease would often spread indefinitely over patients affected with it, from mere contact with the discharges; nurses would become infected from handling the dressings, and surgeons would not be safe in performing any operations; and yet there is not upon record a solitary instance, of a reliable character, from the earliest periods of the profession down to the present time, in which the malady was imparted in this manner. Carcinoma of the penis has never been transmitted during coition. Carcinoma may, however, be inoculated by injecting the juice of infected animals into the veins or tissues of sound animals; and small fragments of carcinoma removed from man have been successfully transplanted in animals.

Of the direct exciting causes of carcinoma the most frequent are injury and chronic inflammatory or irritative processes. Thus, epithelioma of the lip may be caused by jagged teeth, or smoking foul clay pipes; epithelioma of the tongue may result from icthyosis of that organ; psoriasis and eczema of the nipple are occasional precursors of carcinoma of the mamma; epithelioma of the penis is frequently traceable to phimosis; and carcinoma of the uterus and stomach is notoriously the outcome of catarrhal inflammation of those organs. The incompatibility of carcinoma and tubercle, in a state of active growth, is well established. There are, of course, exceptional cases, but they are very uncommon; and yet it not unfrequently happens that the relatives of persons affected with carcinoma die of phthisis. When active phthisis exists in a patient affected with carcinoma, the former malady may so completely obtain the ascendency over the latter as to cause the morbid growth to shrink and wither. Organic affections of the kidneys, liver, bones, skin, nerves, and bloodvessels neither prevent the occurrence of carcinomatous disease nor materially alter its course after its development. The absence of organic degeneration of the heart in those who die of carcinoma has been placed in a very clear light by the observations of Mr. Sibley and Mr. Moore, of the Middlesex Hospital, London, an institution largely devoted to the treatment of this class of subjects.

After carcinoma has made considerable progress, it impresses itself upon the constitution, as is indicated by the worn and haggard features, the sallow complexion, and the emaciated and exsanguineous condition of the system, characters which it is impossible to mistake. The countenance bears the impress of the disease, looking as if it had been stamped with the seal of malignity.

The so-called cancerous cachexia is present chiefly in carcinoma attended with serious involvement of the nutritive functions and imperfect sanguification. In external carcinoma it is frequently entirely absent until internal complications arise, or until the system has been weakened by profuse discharges, or repeated hemorrhages. In carcinoma of the liver, stomach, and other important organs, on the contrary, cachexia often occurs at an early stage of the disease. It generally manifests itself in its worst forms in encephaloid. Its principal characteristics are a sallow, shrunken condition of the features ; a soft, flabby state of the muscles ; rapid absorption of the fat ; and an impoverished condition of the blood, accompanied with abnormal frequency of pulse, night sweats, and general debility.

The immediate causes of death in carcinomatous diseases are various. Most commonly life is worn out by anemia, inanition, and hectic irritation. In many cases the vital powers are seriously undermined, if not completely exhausted, by the violence of the hemorrhage, after the establishment of ulceration. The excessive fetor, the copious ichorous discharges, and the severity and constancy of the pain, always greatly expedite the downward tendency. Sometimes carcinoma destroys life by mechanically impeding the functions of an organ, as when the disease affects the œsophagus, stomach, or bowel. In open carcinoma, attended with a profuse secretion of ichorous, sanious, or sanguinolent matter, death may be occasioned by septicemia, from the absorption of some of the unhealthy fluid into the system.

A spontaneous cure of carcinoma, in any of its forms, is an extremely rare occurrence. Of the causes which may give rise to it, the most frequent is inflammation, followed by gangrene, by which the morbid mass is sometimes lifted bodily out of its natural bed, as neatly, in fact, as if it had been removed with the knife. Rokitansky speaks of the saponification of carcinoma—a conversion of its protein-compounds into fat—as one of the modes of cure, especially of encephaloid ; and he also imagines that such an event may be brought about by the gradual condensation of the stroma of these growths, thus depriving their cells of proper nourishment. The shrunken, shrivelled appearance occasionally seen in scirrhus of the breast of very elderly females, is probably, in great measure, if not solely, due to this circumstance.

Carcinomatous tumors, like other neoplasms, are liable to undergo inflammation and various transformations. Inflammation, softening, and consequent ulceration, are not uncommon, particularly in the advanced stage of the growth. The ulcer shows no disposition to heal, and new carcinomatous nodules are constantly being formed around it, which go through similar changes. Fatty metamorphosis of the cells occurs in all the varieties of carcinoma, and is never entirely absent. It sometimes proceeds to such an extent that the fibrous stroma contracts and shrinks, and the alveoli contain only a few cells and granular debris. This cicatricial tendency is met with in scirrhus, giving rise to what is known as withering or atrophying scirrhus. These retrograde changes are represented at *c* and *d*, fig. 60. The calcareous degeneration has occasionally been noticed in epithelioma and scirrhus. Pigmentation and colloid transformation of the cells, and mucoid degeneration of the stroma are also met with.

The histological varieties of carcinoma are determined by structural peculiarities, or by the relative proportion of the stroma and cells, by the type of the cells, and by certain degenerations and transformations. The clinical divisions are scirrhus, encephaloid, colloid, melanosis, and epithelioma. Of these, scirrhus, fibrous, hard, or chronic carcinoma, is composed of small cells, and a relatively large amount of firm, contractile fibrous tissue. Encephaloid, medullary, soft, or acute carcinoma is characterized by the large size of its cells, and the small proportion of delicate stroma. Colloid or gelatinous carcinoma differs from the preceding varieties only in the fact that the protoplasm of its cells has undergone colloid degeneration. Melanotic or pigmented carcinoma is distinguished by the fact that its cells are infiltrated with granules of melanin. Epithelioma, or epithelial carcinoma, is the variety in which the cells are analogous to those of squamous epithelium ; and it differs from the other varieties in always proceeding from a mucous or cutaneous surface.

1. SCIRRHUS.

Scirrhus, so called on account of its great density and firmness, is rare until after the age of forty, when it is sufficiently common. The period of its greatest frequency is

from the forty-fifth to the fifty-fifth year. Women suffer much oftener than men, but in what proportion has not been ascertained. The influence of habit, temperament, and occupation upon the production of the disease is also undetermined. Of the exciting causes of the disease also very little is known. It generally arises spontaneously, and makes perhaps considerable progress before any suspicion is aroused as to its true character. Occasionally, although seldom, its development is manifestly due to the influence of some external injury, as a blow, fall, or bruise ; and it is not unfrequently the result of catarrhal inflammation, as when it occurs in the mucous surfaces.

Certain organs are more prone to scirrhus than others. Thus the mamma, the pylorus, the rectum, the œsophagus, and uterus are particularly liable to suffer, and it is occasionally met with in the skin, vagina, and jaws. The testicle is singularly exempt from it.

Scirrhus appears under several varieties of form, as the tuberoid, stratiform, and infiltrated, of which the first is the one, surgically speaking, of the greatest interest. The other two occur chiefly in the internal organs, particularly the œsophagus, stomach, colon, and rectum, the submucous connective tissue of which they often so completely transform as not to leave a vestige of the original structure, at the same time that they encroach very seriously, if not fatally, upon the caliber of the tube. The affected part, dense and crisp, cuts almost like fibrous cartilage, and is of a pale yellowish or grayish hue, with white fibrinous intersections. The stratiform variety is occasionally met with in the skin, but the occurrence is uncommon. Scirrhus of the uterus generally presents itself as an infiltration.

The best example of the tuberoid variety occurs in the mamma. Sometimes the tumor consists of one single mass, but more generally it is made up of several, which together may form a growth as large as an orange, or even of a fist, hard, dense, inelastic, and almost incompressible, grating under the knife, of variable shape, but generally globular or ovoidal, movable with, and deeply inlaid in the tissues among which it is situated. The fibrous intersections which pervade the interior of the morbid mass are generally of a dense, firm consistence, and of a grayish, bluish, or rosaceous color. It is questionable whether the fibrous bands, as they are commonly called, are ever entirely of new formation.

A section of a scirrhous tumor, especially in its more matured stages, exhibits a whitish, homogeneous aspect, and yields, upon being scraped, a peculiar fluid, sometimes of a whitish, creamy hue, but more generally of a pale, grayish, turbid appearance, not unlike thick gruel, which contains great numbers of cells, and is known as the cancer juice. It is slightly unctuous to the touch, readily mixes with water, and often contains a considerable quantity of free oil. It exists very sparingly in recent specimens, and is evidently caused by the softening and disintegration of the mass, preparatory to ulceration.

Scirrhus has a very feeble circulation, its vessels being remarkably small, and probably wholly derived from the surrounding parts. The paucity of vessels affords a satisfactory clue to the slow growth, and comparatively small size of the morbid product, and a reason, also, why there is so seldom any considerable hemorrhage after ulceration.

Scirrhus is composed, as is represented in fig. 61, from Arnott, of a stroma of dense, inelastic, fibrous tissue, arranged so as to form alveoli, in which comparatively small and

Fig. 61.

multiform epithelial cells are contained. In the withering or atrophying variety the alveoli are merely represented by a few elongated or fusiform clefts, which contain fatty detritus, or one or more rows of unchanged cells.

The progress of this disease is generally more slow than that of the other carcinomatous growths, both as it respects its tendency to ulceration and to the destruction of life. It is seldom that a scirrhous tumor of the breast becomes an open sore under nine, twelve, fifteen, or eighteen months ; not unfrequently, indeed, several years elapse before it takes on this kind of action. In 1857, I had at my Clinic an elderly lady, once a patient of Sir Astley Cooper, in whom the disease had existed for more than twenty years before there was any disposition to ulceration. Several other cases of somewhat less duration have been under my observation. In general, however, the tendency to ulceration shows itself towards the end of the first or the second year, commencing usually in a superficial portion of the tumor, sometimes at one, and at other times at several points, the process being preceded and accompanied by more or less discoloration of the surface, and by the adhesion of the skin to the subjacent structures. The color is always dark, purple, or

Minute Structure of Scirrhus.

livid, the vessels immediately concerned in its production being enlarged and deeply congested, frequently presenting an appearance as if they were inlaid in the cutaneous tissues. The part at length giving way, an unsightly ulcer is exposed, having hard, steep, rounded edges, and a foul-looking bottom, generally incrusted with spoiled lymph. The discharge is always sanious, ichorous, or sanguinolent, more or less fetid, irritating, and often remarkably profuse. It tarnishes silver, imparts a green color to syrup of violets, and, on admixture with sulphuric acid, evolves a peculiar gas, having many of the properties of sulphuretted hydrogen. No healthy granulations ever form upon such an ulcer; hence it never heals, the plastic matter which it secretes being always speedily devitalized. There are, of course, exceptions to this rule; but they are very uncommon, and I have met with very few. Sometimes the scirrhous ulcer has a remarkably excavated appearance, as if it had been dug out with a punch. The parts immediately round the ulcer are always very hard, tender, discolored, and œdematous.

Another tendency of the scirrhous tumor is to contract adhesions to the structures in and among which it is situated. This disposition, which often manifests itself at a comparatively early period, is always very conspicuous during the later stages of the malady. The immediate cause of the adhesions is the extension or growth of the epithelial cells into the skin, connective tissue, muscles, glands, and even bones, involving all in one common mass.

A tumor of this kind not only affects the parts with which it lies in more immediate contact, but it often extends its influence to others farther off. The structures that are most liable to suffer in this way are the lymphatic glands, which frequently take on the same kind of action, becoming enlarged and indurated, and exhibiting, on section, precisely the same appearances as the original tumor. Sometimes, again, parts still more remote become involved in the morbid action. Thus, in scirrhus of the mamma there is often not only great contamination of the axillary lymphatic glands, but serious swelling of the corresponding arm, either from an extension of the primitive affection, or from obstacle to the return of the blood in the veins.

Thus the tendency of this disease is to spread and to contaminate the surrounding structures, making itself deeply felt not only locally, but constitutionally. In exceptional cases, the morbid influence is closely circumscribed, limited, perhaps for years, to the spot in which it originally appeared; even then, however, it eventually breaks through its barriers, and spreads among the adjoining tissues. Finally, after having remained in the part for a time, nature occasionally makes an effort at extrusion, the tumor being invaded by gangrene, and at length cast off as a slough. Such an occurrence, however, is extremely rare, and I have witnessed only one instance of it. The patient, an elderly lady, fat, and otherwise healthy, had had a medium-sized scirrhous tumor in one of the mammary glands for several years. Suddenly, without any assignable cause, inflammation set in, and in a few weeks the whole mass was lifted from its bed as neatly as if it had been done with the scalpel. Some time afterwards the disease broke out in the axillary lymphatic glands, and made rapid strides towards a fatal termination.

The symptoms of scirrhus necessarily resolve themselves into local and constitutional. The former can only be satisfactorily studied as they appear in an external tumor, as, for example, the mamma. In taking hold of such a growth, one is struck with its extraordinary hardness and density; it is firm, incompressible, and inelastic. If it be of recent origin, it will be found to be perfectly circumscribed and movable, the examiner being able to grasp it with the fingers, and to push it about beneath the skin; at a later period, however, it contracts adhesions to the surrounding parts, and becomes more or less firmly fixed in its situation. The morbid product may occur as a solitary tumor, or several little lumps may appear simultaneously or successively, and, gradually coalescing, a mass of considerable size may thus be formed.

The pain of scirrhus is peculiar. It is sharp, lancinating, or stabbing, darting through the parts like an electric spark, or causing a sensation as if needles were thrust into them. It makes its appearance at an early date, gradually increasing in severity, and becoming at length a source of intense suffering. It may be steady and persistent, but more commonly it is intermittent. It is always aggravated by damp states of the atmosphere, by derangement of the digestive organs, and by whatever has a tendency to impair the general health. In some cases it is of a neuralgic character, and then, instead of being limited to the morbid mass, it often shoots about in different directions among the neighboring structures. During the later stages of the disease it is usually so constant and violent as to deprive the patient of appetite and sleep, thus rapidly urging on the fatal issue.

As the disease advances, the skin is gradually tied down to the morbid mass, and soon becomes hard and livid, its vessels being at the same time very much enlarged and congested. Eventually erosive action sets in, and thus a steep, excavated ulcer is formed, the seat of a foul, ichorous discharge, and incapable of furnishing healthy granulations, or laudable pus, or of undergoing repair. The tumor is now firmly adherent to the surrounding structures, and there is generally, although not invariably, lymphatic involvement. The ulcer sometimes bleeds, but seldom more than a few drachms, or, at most, a few ounces. The flow may be purely capillary, or it may proceed from a tolerably large vessel, arterial or venous, laid open by the morbid action, and unable to retract in consequence of the condensed condition of the circumjacent tissues.

Scirrhus occasionally assumes an atrophic form, causing more or less wasting of the affected organ, and a consequent reduction of its natural size. This form of carcinoma is almost peculiar to the mammary gland of elderly females, after the age of sixty, in whom the disease sometimes remains stationary for a number of years, the morbid growth being characterized by extraordinary hardness, with little, if any tendency, to ulceration and constitutional involvement. On the other hand, a tumor of this kind sometimes attains an unusual bulk, caused by the infiltration of the normal tissues by the carcinomatous matter, the resulting mass being of a dense, compact structure, freely interspersed with fatty and fibrous substance, in an altered condition. In what is called acute scirrhus, the disease advances with extraordinary rapidity, the case often terminating fatally within a few months of its first appearance, from extensive constitutional implication.

Scirrhus, in its earlier stages, produces little or no constitutional disturbance. It is strictly a local affection, annoying and fretting the parts directly involved in it, but not awakening any general sympathies. A little mental disquietude, the result of the consciousness that there is a suspicious tumor or lump, is the only thing that excites attention. By and by, however, the health begins to fail; the appetite is impaired; the sleep is interrupted by the severity and frequency of the pain; the secretions are sadly disordered; the bowels are irregular; the assimilative functions suffer; occasional attacks of fever take place; the flesh and strength gradually decline; the mind is depressed; and life is beset on every side by the treacherous and unrelenting foe. During the latter stages of the malady, sometimes even before there is any serious lymphatic involvement, the countenance assumes a peculiar sallow, cadaverous expression, so denotive of the carcinomatous cachexia; diarrhœa and sweats set in; the limbs become anasarcous; and at length the patient dies utterly exhausted, being literally fretted to death by the disease.

During the progress of this malady secondary scirrhous deposits often appear in other parts of the body especially the liver, lungs, and pleura; the blood is thin and colorless; and the solids are pale, flabby, and wasted. Even the bones often experience important changes, particularly those of the extremities, which are sometimes rendered so fragile as to give way from the slightest cause. Many years ago I had under my charge, on account of scirrhus of the mamma, a lady of seventy-three, who broke her right femur a few days before she died, simply by turning over in bed.

2. ENCEPHALOID.

Encephaloid has various synonyms, of which the most common are soft, acute, medullary, and cerebriform carcinoma, and fungus hematodes. All these various appellations have reference either to the appearance, consistence, or progress of the morbid product, and are, therefore, more or less appropriate. That of encephaloid, however, is, on the whole, the least objectionable, and is the only one that ought to be retained.

Encephaloid generally comes on spontaneously, although, now and then, it is directly traceable to the effects of external injury, as I have witnessed in a number of instances. Thus, in 1861, I attended a medical gentleman, sixty-eight years of age, on account of an encephaloid tumor of the maxillary sinus, the result of an accidental blow received several months previously. A young man hurt his testicle in riding on horseback. The organ soon began to increase in bulk, the lymphatic glands of the groin became involved, and in less than six months death occurred from soft carcinoma. In both of these cases the disease was of unusually rapid development, and, such, I believe, will generally be found to be the fact when it is caused by violence.

The affection is most common in the liver, kidney, ovary, testicle, mamma, prostate, and salivary glands. Both sexes are liable to it, but the greatest number of cases occur in females between the fortieth and sixtieth years. Encephaloid carcinoma, like scirrhus, consists of an alveolar stroma with inclosed epithelial cells; but it differs from the latter

growth in that the stroma is more delicate and the cells are more numerous and of larger dimensions, as is well represented in fig. 62, from Green.

Fig. 62.

In regard to its arrangement, encephaloid occurs under three varieties of form, as a tumor, a stratum, and an infiltration, the first being the most common, and surgically considered the only one of any particular interest. It varies in volume from a pea to that of an adult's head, its shape being generally somewhat ovoidal, and its surface more or less lobulated.

On section an encephaloid tumor presents a white or grayish pulpy appearance like that of the fœtal brain. In not a few specimens the grayish-white basis is mottled with pink, red, or brown areas, which are indicative of increased vascularity, and slight effusions of

Minute Structure of Encephaloid.

blood. When the tissue resembles a recent coagulum, or contains spaces filled with blood, the tumor is termed hematoid or telangiectatic carcinoma, which is synonymous with fungus hematodes. This variety of tumor is met with principally in the mamma, the testicle, and the ovary.

Encephaloid, being an extremely vascular structure, is endowed with a high degree of vitality, growing generally with great rapidity, and often attaining a very extraordinary bulk within a few months from its first appearance. Its vessels, which are unusually large, are arranged in a close, intricate, and retiform manner, and its circulation is always remarkably active, thus strikingly contrasting with that of scirrhus, and affording a ready explanation of the differences in the rapidity and size of the two formations. The walls of the vessels are unusually brittle, and they are, therefore, liable to give way under the most trifling causes, producing those apoplectic depots which are so often seen in their interior, and those frightful hemorrhages which occasionally attend their open condition.

It is not unusual for encephaloid tumors to contain serous cysts, thus complicating their structure, and occasionally throwing a doubt over their diagnosis. In general, the cysts are small; but in one instance, within my observation, a cavity of this kind contained fully a pint of serum, its walls having a peculiar honey-combed appearance. Apoplectic depots are, as already stated, most common in the hematoid variety of encephaloid growths.

It is seldom that an encephaloid tumor, after having taken a fair start, remains even temporarily stationary; on the contrary, its tendency is to proceed, steadily and regularly, in its work of disorganization, until it destroys life either by hemorrhage, by irritation, or by visceral complications, the period at which this takes place varying, on an average, from nine to twelve months. Death sometimes occurs in an almost incredibly short period. Great softness of texture, bulk, and rapidity of growth are the circumstances which particularly predispose to an early unfavorable issue.

The period at which an encephaloid tumor becomes an open ulcer is indefinite; sometimes this takes place within a few months, at other times not under a year, or a year and a half from the first appearance of the disease, although this is uncommon. The immediate cause of the ulceration is the pressure of the morbid mass upon the skin, the formation of an abscess, or the occurrence of a slough, leaving a sore, the edges of which are thin, undermined, jagged, or irregular, while the bottom, which is sometimes of considerable depth, has a foul, bloody, fungous aspect. The parts immediately around are of a deep red, livid, or purple color. The discharge is usually profuse, and of a sanious, ichorous, bloody, or sanguinolent character, pure laudable pus being rarely, if ever, met with. Copious hemorrhage occasionally takes place, especially in the hematoid variety of the disease, and by its frequent repetition rapidly undermines the general health, urging on the fatal crisis. The occurrence is particularly common in encephaloid of the uterus and mamma. Of the many cases that I have seen of the encephaloid ulcer, not one ever healed even temporarily. Intractability is one of its distinguishing features.

Lymphatic involvement often occurs at an early stage of the disease, sometimes, indeed, long before ulceration sets in; at other times, however, not until the tumor has become an open sore. The general law is that the more rapid the growth is the earlier will there be disease in the neighboring lymphatic glands, and conversely. The constitutional cachexia is always well marked in the more advanced stages of the affection, and the patient's doom is often depicted in legible characters upon his countenance several months before it is finally sealed in death.
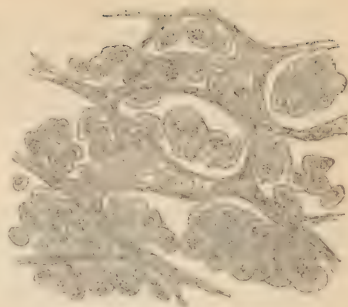
An encephaloid tumor is distinguished by its comparative softness, by the rapidity of its growth, by its great bulk, and by its lobulated surface. The pain is generally slight, at least until the occurrence of ulceration; and there is occasionally considerable, sometimes, indeed, enormous, enlargement of the subcutaneous veins with more or less involvment of the neighboring lymphatic glands. In its earlier stages, the tumor is movable, as in scirrhus, but as it advances it contracts adhesions, and at length becomes permanently fixed.

3. EPITHELIOMA.

There is a class of affections which was formerly known under the name of scirrhus, from its supposed identity with that disease, but which modern research has shown to be so different from it as to entitle it to be regarded as a separate formation. The affections comprised under this head are the various forms of malignant disease of the cutaneous and mucous tissues, more particularly carcinoma of the lip, gums, tongue, face, anus, rectum, uterus, vagina, and penis. They are not, however, limited to these parts; for they sometimes invade, secondarily, the deeper structures, as the bones, muscles, lymphatic glands, liver, and lungs, although their occurrence here is very uncommon. The name by which these formations are now generally designated is epithelioma, or epithelial carcinoma.

Epithelioma is more common in men than in women, the latter being more liable to scirrhus. Of 1467 persons admitted into the Cancer Hospital in London, on account of this disease, 1022, according to the statement of Dr. Marsden, were males. In men the lip and penis are most frequently attacked. What is called chimney-sweeper's cancer is merely a form of epithelial disease of the scrotum. Rodent ulcer, or the noli me tangere of the older writers, is nothing but epithelioma of the skin of the face and other parts of the body, an affection sufficiently common in both sexes, and often committing the most frightful ravages. Epithelioma occurs also in the tongue, at the anus, in the rectum, in the uterus, in old scars, and in chronic ulcers. The cauliflower excrescence of the uterus, first described by John Clark, of London, belongs to this variety of carcinoma. Whatever the form may be, the disease seldom shows itself before the age of thirty-five or forty, and then usually only in one part of the body.

The causes of this disease are generally inappreciable. Sometimes it is directly traceable to external injury, as a blow, long-continued pressure, or some particular irritation. Thus, Dr. Da Costa has mentioned to me the case of a shoemaker, where it was clearly attributable to the effects of a small board worn habitually upon the abdomen while the man was working at his trade. A man, aged fifty-nine, consulted me on account of a carcinoma of the lip and cheek, induced by a wound received five months previously from the prong of a fork in eating. Epithelioma of the lip is often charged to the irritation produced by the pipe in smoking. Chimney-sweeper's cancer is generally supposed to be occasioned by the lodgment of soot in the folds of the scrotum. Sometimes the disease originates in a wart, mole, or cicatrice. Epithelioma of the penis has been very commonly referred to the irritation arising from want of cleanliness due to the existence of a long and tight prepuce. A sharp tooth, constantly brought in contact with the tongue, may, it is believed, serve as an exciting cause of carcinoma of that organ. In 1866, I excised from the bridge of the nose of a lady, seventy-five years of age, an open epithelial tumor, fully half an inch in thickness and diameter, induced six weeks previously by the accidental prick of a needle. In 1877, a man, upwards of forty years of age, was brought to the College Clinic on account of a small epithelial growth on the right cheek caused by a slight wound inflicted with the razor in the act of shaving less than two months before.

The disease sometimes originates in the scar of an old burn, as in the case of a middle-aged man, a patient at the College Clinic, whose arm I amputated at the shoulder, in 1864, on account of an enormous epithelial ulcer consequent upon an injury of this kind received ten years previously. Many years ago I attended a young man for an epithelial ulcer of the anus, which had its rise, apparently, in a protracted eczematous affection of the skin and mucous membrane. Mr. Shaw, of London, has published the particulars of a case in which the disease suddenly broke out in an issue which had been kept open for thirty-five years; and Mr. Clark successively amputated both legs of a man whose bunions, long in a state of ulceration, had been invaded by epithelial carcinoma. Mr. P. C. Delagarde, of the Devon and Exeter Hospital, England, has reported two cases of epithelioma of the cicatrice of a burn, coming on, respectively, forty and sixty years after the accident.

Cases have been collected which tend to prove that the disease occasionally manifests a

hereditary predisposition. Dr. Foster, of Terre Coupee, Indiana, has communicated to me the particulars of three cases which occurred in three members of the same family, two having died of epithelioma of the face, and one of epithelioma of the foot.

The form which epithelial carcinoma assumes is greatly influenced by that of the structures in which it is situated. Its outlines are, as a general rule, so ill-defined and irregular as to defy accuracy of description. The most common varieties are the tuberculated, mammillated, and cauliflower-like. Now and then they present a lobulated, conical, disk-shaped, pedunculated, or even a pendulous appearance.

Epithelioma generally begins as a tubercle, crack, or wart-like excrescence, hard to the touch, movable, and somewhat tender on pressure. As the disease advances, it extends in different directions, and assumes a more distinctive character. By and by ulceration sets in, sometimes almost simultaneously at several points, the exposed surface having a foul, unhealthy, fungating appearance, with irregular granulated edges, and a hard, rough base. The discharge is generally abundant, and of a thin, sanious, acrid description, often eroding the skin in the neighborhood. The ulcer is intractable, manifesting no disposition to heal, or, if granulations form, they speedily degenerate and lose their vitality, their recuperative powers being too feeble to carry on the work of repair. Once begun, the disintegrating action never stops, and hence its ravages are often most frightful, as, for example, in the case from which the adjoining cut, fig. 63, was copied, where the disease successively involved skin, muscle, bone, cartilage, and fibrous membrane, sparing nothing that came in its way. The pain, like that of scirrhus, is of a sharp, darting, or pricking nature, and often extends through the surrounding parts. Hemorrhage occasionally occurs, chiefly in the fungating form of the epithelial ulcer, and may be sufficiently copious to cause serious debility, especially when an artery or a vein of considerable size is laid open.

During the progress of the disease, lymphatic involvement occurs; sometimes early, but generally not until after the eighth, twelfth, or fifteenth month. The constitutional suffering, also severe, usually sets in later than in ordinary carcinoma, although ultimately it is not less fatal.

Fig. 63.

Epithelial Carcinoma in a state of Ulceration.

Occasionally the disease shows itself successively in a great number of organs. In a case observed by Virchow, in a man, seventy-three years of age, it affected both lips, lymphatic glands, clavicle, ribs, lungs, heart, liver, and kidneys. In the cylindrical-celled variety of the disease secondary growths in the lymphatic glands are not uncommon, and the viscera are occasionally affected.

Epithelioma consists essentially of an ingrowth of epithelial cells into the deeper tissues. Its stroma is not like that of the alveolar connective-tissue matrix of scirrhus or encephaloid, although it is analogous to it, and the cells retain the type of those of the surface from which the growth originates. When the skin is affected the cells resemble epidermis cells; when the tubular glands of the intestine are the source of origin of the tumor, the cells, on the other hand, are cylindrical. Hence, epithelioma is anatomically divided into the pavement-celled, and the cylindrical-celled varieties. In the former variety, which is so common about the face, penis, labia, and uterus, the squamous epithelial cells are arranged in simple or branched cylinders or plugs, which grow into the stroma of the cutis or connective-tissue framework of the mucous membrane. These appearances are well represented in fig. 64, from Green. As the cells grow older they are very frequently closely packed together, forming nests, and assuming a concentric arrangement, like the layers of an onion. They are often visible to the naked eye, and are very characteristic of, although not entirely peculiar to, epithelioma. In the cylindrical-celled tumor, which is found in connection with mucous membranes with columnar epithelium, as those of the stomach, rectum, and uterus, the cells are arranged on the walls of the connective-tissue stroma after the normal type. These growths have a soft consistence, readily ulcerate, and are disposed to bleed.

Epithelioma is generally comparatively tardy in its growth. In a case of epithelioma of the tongue, reported by Dr. Da Costa, twenty-two years elapsed from the appearance of the disease to the time of its removal by operation. In the lip the disease often lasts a number of years before it terminates fatally, although this is not its ordinary tendency, for most
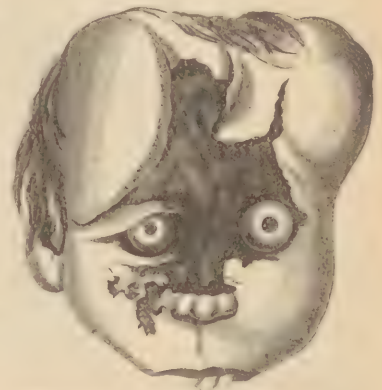
Fig. 64.

Minute Structure of Pavement-celled Epithelioma.

persons die in from eighteen months to two years. I have seen rodent ulcer of the face continue its ravages for nine, fifteen, and even twenty-five years before it finally caused

Fig. 65.

Minute Structure of Cylindrical-celled Epithelioma.

death. Under such circumstances, the ulceration occasionally ceases for a time, and then recurs, perhaps now with increased vigor.

No experiments that have yet been performed to test the inoculability of epithelioma have been successful. A clinical observation, however, published by Mr. Nunn, of London, seems to countenance such a view. A woman, thirty-four years of age, had a carcinoma of the rectum, which perforated the posterior wall of the vagina, forming a fistulous opening the size of a goose-quill. On the anterior wall of the vagina, exactly opposite this opening, and in immediate contact with it, was a small, inflamed circular patch, superficially ulcerated, studded with little red granulations, presenting, under the microscope, all the characteristic features of carcinoma. Here the mere contact of a healthy with a diseased surface was, apparently, sufficient to propagate the growth.

4. COLLOID.

Colloid is one of the most uncommon of the carcinomatous formations. The name by which it is now usually known has reference to the peculiar jelly-like appearance of one

of its principal constituents, and is therefore quite appropriate. It has also been described under the terms gelatiniform, alveolar, cystic, and gum cancer.

The favorite seats of this morbid product are the liver, stomach, rectum, ovary, and mamma.

Although colloid may appear, simultaneously or successively, in a considerable number of organs, it manifests less tendency to general diffusion than any of the other carcinomatous formations, except the epithelial. It is rarely met with before the fortieth year, and is most common between forty-five and fifty-five years.

Colloid appears under two varieties of form, as a tumor and as an infiltration, the latter being most common in the alimentary canal, particularly the stomach and rectum; the former, in the mammary gland and ovary. In the infiltrated variety, the new matter occupies the meshes of the connective tissue, forming cysts, from the size of a mustard seed to that of a hazel-nut, which are filled with the characteristic jelly-like matter, and which, as they increase in volume and number, so completely subvert the primitive structures as ultimately to leave no trace of them. In the other variety of colloid, there is a distinct tumor, from the volume of a marble to that of an adult head, of a globular, rounded, or irregular shape, and of a firm, dense consistence.

The surface of the colloid tumor is generally rough, knobby, or distinctly lobulated, according to the volume and arrangement of the component cysts. Occasionally it bears a strong resemblance to the exterior of a pudding stone. In the larger masses, vessels of considerable size may be seen running over the surface, and penetrating the walls of the principal cysts, without, however, passing through their contents.

Colloid consists of two component elements, a stroma, and the peculiar cell-containing, jelly-like matter from which the neoplasm derives its distinctive features. The former is of a fibrous character, and is arranged in such a manner as to form cells, loculi, or cavities, from the size of a pin-head up to that of a small marble, rounded, ovoidal, or angular, and communicating with each other. The stroma generally possesses great firmness and density; it creaks under the knife, and is of a dull, whitish, grayish, or pale yellowish color. It receives an abundant supply of vessels, as I have satisfied myself by dissection, and as is evinced also by the rapid development of the morbid growth, and the great bulk which it occasionally attains. In one case, in particular, I had no difficulty in tracing several large, straggling arteries into

Fig. 66.   Fig. 67.

Colloid Carcinoma. Fig. 66 exhibits the External Appearance, and Fig. 67 the Internal Structure.

a tumor of this kind, showing that it had a very active circulation. The cystiform structure of colloid is easily recognized, as it constitutes one of the most remarkable features of the morbid growth. It is well illustrated in the annexed cuts from a preparation in my collection; fig. 66 showing the external arrangement, and fig. 67 the internal.

The other element of colloid is an unrecognizable product, of a whitish, greenish, or yellowish color, and of the consistence of ordinary jelly, whence the name by which the disease is usually known. In the older spaces the matter is sometimes as firm as moist cheese, or the albumen of a hard-boiled egg, opaque, and of a white, pearly, or yellowish hue, interspersed with minute dark points. Sometimes, again, it resembles currant jelly, half-dissolved glue, or a solution of gum shellac. However this may be, it never adheres to the walls of the alveoli, and is, therefore, easily enucleated, or pressed out. When perfect clearance has been effected of the loculi of a mass of colloid, the fibrous structure exhibits very much the appearance of a piece of sponge, the alveolar arrangement being then particularly conspicuous, hundreds of cavities being often visible upon a surface less than an inch in diameter.

Under the microscope colloid differs from scirrhus and encephaloid mainly in the large size of the alveoli and in the contained gelatinous material, within which are included the so-called colloid corpuscles, or large, refractory, vacuolated cells, which are sometimes marked by several delicate concentric lines, giving them an oyster-shell appearance. With the advance of the metamorphosis, the cells disappear almost entirely, and nothing remains except large laminated spaces, from the $\frac{1}{60}$ to the $\frac{1}{100}$ of an inch in diameter, usually oval and grouped, nearly transparent, and interspersed with elongated nuclei, small, nucleated cells, and brood cells. The annexed sketch, fig. 68, from Rindfleisch, magnified 300 diameters, shows the alveolar formation of the stroma, and concentric cir-
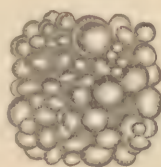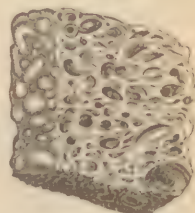
Fig. 68.

Minute Structure of Colloid.

cles interspersed with granular matter and slender nuclei, and inclosing oval, well-defined, nucleated cells. This arrangement is very common, and most characteristic of colloid carcinoma.

From the fact that colloid was until a comparatively recent date confounded with myxoma, it is impossible, in the existing state of our knowledge, to assign to it a proper position in the scale of the carcinomatous formations. In the mammary gland, in which organ he has carefully studied its clinical features, Dr. S. W. Gross finds that, when compared with scirrhus, its progress is slow, that the lymphatic glands are affected late in the disease and in only one-fourth of all cases, and that metastatic tumors form only after it has existed for several years. The comparative immunity of colloid from local and general dissemination is ascribed by Dr. Gross to the fact that the migration of the cells along the lymphatics to the associated glands and the viscera is delayed or prevented by the colloid degeneration, a change which acts the part of a cementing substance and renders the cells immobile.

5. MELANOSIS.

Melanotic or pigmented carcinoma is a variety of encephaloid carcinoma, the only difference being that the cells of the former are impregnated with melanin, the appearances of which are represented in fig. 69, from Bennett. It has been observed in the breast, ovary, rectum, and parotid gland, but the history of its life is so mixed up with that of melanotic sarcoma that scarcely anything is known of its clinical features.

Fig. 69.
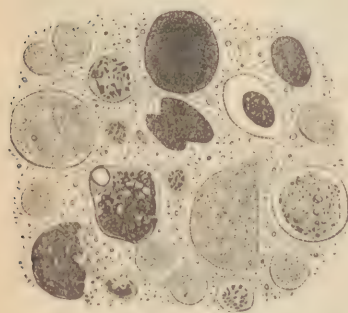
Pigmented Cells of Melanosis.

After having remained stationary for an indefinite period, the tumor manifests a disposition to disintegration, the softening process generally beginning at some superficial point, and thence gradually leading to the establishment of a foul, non-granulating, unhealthy ulcer, which no skill can cure. The discharge is generally of a sanious character, mixed with and discolored by the pigment. Its progress is usually more tardy than that of scirrhus; but the general health often suffers long before ulceration sets in, the patient becoming thin, haggard, sallow, and exhausted.

DIAGNOSIS OF CARCINOMATOUS TUMORS.

Epithelioma is usually sufficiently easy of recognition. Its situation at the junction of the skin and mucous membranes, or upon either of these structures; its origin in a crack, fissure, or wart-like excrescence; its extraordinary firmness, the part feeling like a mass of fibro-cartilage; its slow growth; its small size; and the absence, for a long time, of severe pain and constitutional taint, are features that cannot deceive.

The only characteristic sign of melanosis is the peculiarity of the color of the tumor; hence, when it is situated superficially, as when it occupies the parotid region, it is quite impossible to mistake the nature of the disease.

Colloid tumors are liable to be confounded with fibrous, cartilaginous, myxomatous, and sarcomatous formations; but a careful consideration of the history of the case, and a thorough examination of the morbid growth, will generally serve to clear up any doubt that may arise in regard to the diagnosis. Colloid tumors are tardy in their progress, smooth or rough on the surface, of uniform consistence, and free from pain, their bulk being usually small, and the general health greatly disordered. Fibrous tumors enlarge slowly, seldom attain a great bulk, and do not usually seriously undermine the constitution. The cartilaginous growth is harder and less elastic than the colloid; its progress is rather

rapid, and its outlines are always well defined, which is seldom the case with alveolar carcinoma. A sarcoma often attains an immense size in a few months, especially in the bones, jaw, and the mammary gland, is generally of a globular shape and uniform consistence, and seldom contaminates the neighboring lymphatic glands. Myxoma is softer, grows more rapidly, and attains a far greater volume than colloid; the former is not characterized by adhesions or lymphatic involvement; and metastatic tumors are infinitely less common than in colloid.

Almost the only diseases with which encephaloid is liable to be confounded are scirrhus and sarcoma, and it will be therefore necessary to point out their differential diagnosis. For this purpose I give the subjoined table of the characteristics of the three affections.

ENCEPHALOID.	SCIRRHUS.	SARCOMA.
1. The tumor is soft and elastic, but not uniformly.	1. Uniformly hard and inelastic, feeling like a marble beneath the skin.	1. May be firm, tense, and elastic; generally uniformly soft, and apparently fluctuating.
2. It grows rapidly and soon acquires a large bulk, perhaps ultimately attaining the volume of an adult's head.	2. Growth is slow, and bulk comparatively small; the tumor rarely, even in the worst cases, exceeding the volume of a large fist.	2. May remain stationary, or nearly so, for many years; awakened into activity, it progresses more rapidly than encephaloid, and may attain an enormous volume in a short time.
3. The pain is slight, and erratic, until ulceration begins, when it becomes more severe and fixed.	3. The pain begins early, is distinctly localized, and is of a sharp, darting, burning, or lancinating character.	3. Rarely pain until ulceration sets in, and even then usually insignificant.
4. There is nearly always marked enlargement of the subcutaneous veins.	4. In scirrhus these vessels retain their natural size, or are only slightly enlarged.	4. The subcutaneous veins only slightly, if at all, enlarged.
5. The ulcer is foul, deep, and excavated, with thin, undermined, and livid edges, and is subject to frequent and copious hemorrhage.	5. The ulcer is incrusted with spoiled lymph, and has steep, abrupt edges, looking as if it had been scooped out of the part; bleeding little, and seldom.	5. The ulcer is fungous, and subject to frequent and copious hemorrhage.
6. There is generally early lymphatic involvement.	6. Usually not until late, or shortly before ulceration occurs.	6. Singularly free from lymphatic involvement, or, if the glands are affected at all, they become so quite late.
7. More frequent before the age of forty-five than scirrhus.	7. Seldom before the age of forty-five.	7. Generally before the age of forty, and most commonly between that age and twenty.
8. Is most frequent in the mamma, testicle, ovary, prostate, and salivary glands.	8. Rarely occurs in the testicle, ovary, and prostate.	8. Always begins in the connective tissues, particularly sarcoma of the extremities; most common in periosteum, bones, and the mamma.
9. The disease usually terminates fatally in from nine to twelve months.	9. Seldom sooner than eighteen months or two years.	9. No reliable data; patients, however, often survive many years, even after repeated extirpation.

It is not improbable that an encephaloid carcinoma might be confounded with a chronic abscess, or an aneurism, especially when it is so situated as to receive an impulse from a neighboring artery. The very mention of the possibility of such an occurrence will be sufficient to put the practitioner upon his guard, and serve to point out to him the absolute necessity of the most profound caution in every case of a suspicious character.

SECT. VII.—TREATMENT OF MORBID GROWTHS.

In their management, tumors may, for the sake of convenience of description, be divided into the benign and malignant. The former comprise the cystic, fatty, fibrous, cartilaginous, osseous, muscular, vascular, lymphangiomatous, neuromatous, adenomatous, and papillary formations. The latter include myxoma, sarcoma, lymphoma, and carcinoma.

1. TREATMENT OF BENIGN TUMORS.—The treatment, medical as well as surgical, of innocent tumors, having been succinctly discussed under each respective variety, it is only necessary here, in order to place the whole subject in a more tangible form, that I should briefly recapitulate the more prominent points of what has already been said.

Few, if any, of the innocent formations are in the slightest degree amenable to remedies, whether locally applied or internally administered. The more simple forms of cystic tumors, and certain forms of goitre, occasionally disappear under topical and constitutional treatment; but even in these, in many cases, we find ourselves completely baffled, however perseveringly or judiciously the curative plan may be carried out. The most trustworthy local remedies, unquestionably, are tincture of iodine and the ointment of biniodide of mercury, variously diluted, and applied once or twice in moderation in the twenty-four hours. Chloride of ammonium also possesses powerful solvent properties. A poultice made of bran and salt water is an excellent sorbefacient. Leeches and blisters are useful when the morbid growth is hot and congested, or actually inflamed; and, under similar circumstances, great benefit occasionally accrues from lotions of acetate of lead and Goulard's extract. Systematic compression with adhesive strips, the roller, or the air-cushion, is sometimes serviceable, as is shown in certain tumors of the mammary gland, the testicle, and other parts of the body.

The only internal remedies at all worthy of consideration, in the treatment of benign tumors, are iodine, either in substance, tincture, or Lugol's solution, iodide of iron, iodide of potassium, mercury, chloride of ammonium, and tartar emetic. These articles may be given by themselves, or in various forms of combination, care being taken that the dose is not so large as to oppress the stomach, and that the prescription be occasionally pretermitted for a short time, as the effects are thus greatly enhanced. The diet must, of course, be properly regulated, being light, non-stimulant, and at the same time not too nutritious; the bowels are kept gently open, and the utmost attention is paid to the maintenance of the secretions.

How far electrolysis is to be trusted in the treatment of innocent tumors is a problem which further experience alone can solve. The chief affections in which it has been employed are, hydrocele, hydatid tumors of the liver, nævoid growths, and certain forms of goitre, in which it has occasionally been beneficial, having been followed, in some of the cases, by a permanent and rapid cure. The manner in which electrolysis acts is probably by the induction of inflammation, the perturbating effects of which put a stop to further growth at the same time that they promote the absorption of its various constituents, fluid as well as solid. To the harder varieties of innocent tumors, as the fibrous, cartilaginous, and osseous, this method of treatment does not seem to be adapted: at all events, I am not aware that any successful cases of it have been reported. A similar remark is applicable to the various forms of ordinary cysts and lipomas. Papillary growths, as warts on the skin and genital organs, have occasionally been cured by it.

With respect to the removal of innocent tumors, a few precepts may here be introduced for the guidance of the surgeon. The knife, of course, always claims preference in every operation of this kind; but now and then a case occurs in which, on account of the danger of hemorrhage, or the difficulty of access, the écraseur is used. The practice of removing innocent tumors with caustics has long been obsolete.

1st. Interference should, as a rule, be avoided when the tumor is stationary, or nearly so, painless, and not inconvenient by its size, weight, or situation.

2dly. If an operation be determined upon, the system should always be subjected to a certain degree of preliminary treatment, even when the tumor is comparatively small, experience having shown that extirpation is often followed by erysipelas.

3dly. While the object should be to effect the most thorough removal, care should be taken not to interfere unnecessarily with the surrounding tissues, but to respect them as much as possible by keeping the knife in close contact with the morbid growth.

4thly. When the tumor is of unusual bulk, it will generally be necessary to remove a portion of skin by including it in an elliptical incision, otherwise it should be retained, due allowance being made for its astonishing contractile powers. If this precaution be neglected, there may be a deficiency of flap when the surgeon comes to approximate the edges of the wound.

5thly. Diseased integument should always be removed along with the morbid growth, the knife being carried around it elliptically.

6thly. Extirpation may generally be readily effected by a single incision carried across the centre of the tumor, either vertically, horizontally, or curvilinearly. It is only when, as already stated, the morbid growth is very large, or when there is diseased integument, that an elliptical incision will be required.

7thly. The incisions should be directed in such a manner as to favor drainage, and to prevent bagging. Hence, one of the extremities should always correspond with the most dependent portion of the tumor. In operating upon parts that are habitually exposed, as

the face, head, neck, hand, and arm, it is a matter of great importance to avoid the occurrence of unseemly scars. To facilitate this object, the skin should, as originally suggested by Dr. John H. Packard, be divided obliquely, the knife being held edgewise in making the incisions, so as to impart to the borders of the wound a bevelled appearance. A wound thus made, heals, Dr. Packard thinks, more readily than one made with a straight cut, and hardly leaves a perceptible cicatrix.

8thly. When the morbid growth is very vascular, uncommonly soft, or very firmly adherent to the integument, the removal will be greatly facilitated if the skin be divided, as a preliminary step, upon the grooved director, the knife being thus prevented from penetrating the proper substance of the tumor.

9thly. By keeping the knife in close contact with the tumor, the whole mass may sometimes be speedily and effectually enucleated with the hand, finger, scalpel, scissors, or scraper. Another advantage of such a precaution is the avoidance of hemorrhage.

10thly. When the mass is very large, pendulous, and vascular, as, for example, in those enormous growths constituting what is called elephantiasis of the scrotum, the bleeding may be essentially diminished by elevating the tumor and pressing the blood out of its veins immediately prior to the operation either with the hands or with the elastic bandage.

11thly. There are certain kinds of morbid growths, as, for example, polypoid myomas of the uterus and nævoid tumors, that are more easily and safely removed with the écraseur than with the knife, on account of their peculiar situation, and the danger of hemorrhage. In using this instrument, the part, as a preliminary step, is thoroughly isolated by transfixing its base with pins, and then gradually divided by linear crushing, the chain with which it is provided being well adapted to such an object. The stump must not be disturbed after the operation is completed, as this might excite bleeding and interfere with the healing process.

12thly. Any large arteries that may be divided should either be compressed by an assistant until the extirpation is completed, or they should immediately be tied, loss of blood being carefully guarded against in all proceedings of this kind. When the surgeon is operating alone, or when he has no good aids, the bleeding may be temporarily checked with the serrefine, fig. 70, a kind of wire forceps, the contrivance depicted in fig. 71, or Nunneley's forceps, fig. 72. These instruments maintain their hold by their own elasticity, and will be found to be of great service in extensive and tedious dissections, especially when the same artery is obliged to be cut several times.

Fig. 70.   Fig. 71.   Fig. 72.

Serrefine.   Small Forceps for Temporarily Checking Hemorrhage.   Nunneley's Artery Forceps.

13thly. When all oozing of blood has ceased, the edges of the wound are accurately approximated by suture and adhesive strips, aided, if necessary, by a light compress and bandage, to keep the flaps in close contact with the raw surface beneath, as the object is to secure union by the first intention.

Lastly. The part is to be kept perfectly at rest until the wound is healed, and the case treated, in every respect, upon ordinary antiphlogistic principles, the greatest attention being paid to drainage and cleanliness. In general, the dressings should not be disturbed before the end of the second day, especially if the absence of fetor and discharge indicates favorable progress.

2. TREATMENT OF MALIGNANT TUMORS.—In the treatment of the various forms of malignant growths all internal remedies, of whatever kind and character, have proved unavailing in arresting their march, or in modifying their action so as to render the surrounding structures tolerant of their presence. The vaunted specific of the empiric, and the enchanted draught of the honest but misguided enthusiast, have alike failed in performing a solitary cure; and the science of the nineteenth century must confess, with shame and confusion, its utter inability to offer even any rational suggestions for the relief of this class of affections. But, although this is the case, yet it by no means follows that the subjects of these complaints may not be benefited by general treatment, if it be directed by common sense and sound judgment. Every practitioner of experience knows how

much ordinary local diseases are influenced by constitutional measures; and if this be true of these lesions, how much more true must it be of the malignant, in the production of which both the solids and fluids play such an important part. Hence, when surgical interference is inappropriate, the attention of the surgeon should be particularly directed to the patient's diet, bowels, and secretions, and to the avoidance of all sources of local irritation, calculated to favor the morbid growth, and hasten the fatal issue.

The diet should generally be of a bland and unirritant character, and yet at the same time sufficiently nutritious to preserve a sound condition of the blood, and to maintain the tone of the muscular system. All condiments, coffee, strong tea, pastry, hot bread, and the coarser kinds of vegetables and meats, should be abstained from. Eggs, fish, oysters, and the white kinds of meat, may be moderately used once a day, but not oftener, unless there is some special reason for it, founded upon the state of the general health. Frequently a purely farinaceous and milk diet will be found to answer better than any other, the patient not only thriving under it, but the disease being apparently kept in check by it.

The bowels should be maintained in a soluble condition, but all active purgation must be carefully avoided. The most suitable aperient, when a tendency to constipation exists, is a blue pill, with one grain of ipecacuanha, or equal parts of blue mass and jalap, at bedtime, followed, if necessary, by a Seidlitz powder in the morning. If gastro-intestinal irritation arise, the blue mass may advantageously be replaced by a small portion of calomel. In this way, while the bowels are maintained in an open state, the secretions are also duly preserved; a matter of no little moment in the treatment of all malignant diseases without exception, especially when they are attended with marked constitutional disturbance.

Sleep is procured and pain allayed by morphia given, if possible, hypodermically once or twice in the twenty-four hours. When the suffering is of a neuralgic character, the anodyne may be administered by the mouth in union with arsenic or arsenic and strychnia.

When marked debility exists, tonics, as quinine and iron, a generous diet, and the use of brandy, wine, ale, or porter, are imperatively demanded. Night sweats are best controlled by sulphate of atropia, aromatic sulphuric acid, oxide of zinc, or acetate of lead and tannic acid.

Perfect rest of the affected part, and entire freedom from pressure and excitement, are of paramount moment. Thus, in carcinoma or sarcoma of the breast or testicle, the organ must be well suspended, the dress worn loose, and all rude manipulation scrupulously abstained from. If the part be tender, hot, and swollen, or œdematous, some mildly astringent and anodyne lotion will be of service, or the surface may be painted several times a day with a weak solution of iodine. When the local inflammation is unusually severe, as evinced by the discoloration and pain, nothing, according to my observation, affords such prompt and decided relief as the application of a few leeches, unless it be a small blister, retained until free vesication is produced. Some cases are greatly benefited by the use of an opium, belladonna, or cicuta plaster, renewed every eight, ten, or twelve days. All caustic applications should be carefully avoided, inasmuch as they can never do any good, but may do a great deal of harm by establishing sores which it will afterwards be impossible to heal.

In open malignant growths, the sore must be kept constantly clean by frequent ablutions; while the excessive fetor which so generally attends must be allayed by the free use of permanganate of potassium and other articles. The best dressing is an emollient poultice, particularly one made of powdered elm bark, sprinkled, if there is much pain, with a little morphia, pulverized opium, or laudanum. If the ulcer is very sensitive, it should occasionally be very lightly touched with solid nitrate of silver, or kept constantly covered with very dilute ointment of acid nitrate of mercury. When the discharge is very profuse, sanious, and offensive, a lotion composed of two to four drops of nitric acid to the ounce of mucilage of gum arabic, or of five grains of chloral to the ounce of water or cosmoline, will be found exceedingly beneficial in diminishing its quantity and changing its character. Carbolic acid is also an excellent remedy, the only objection to it being its offensive odor.

The affected glands in the neighborhood of the diseased organs often require attention, especially when they are very painful and bulky. The remedies should be of an anodyne and antiphlogistic character, especially leeches, iodine, and saturnine lotions in union with laudanum.

The hemorrhage attendant upon open carcinoma is generally easily controlled with Monsel's salt, or a thick coating of Richardson's styptic, consisting of collodion with the addition of three grains of tannic acid to each ounce of fluid. Acupressure may be required when a small artery or vein has been laid open.

The electrolytic treatment of malignant growths has, on the whole, been very unsatisfactory. The details of the reported cases are obscure, and the tumors said to have been malignant, and removed by this measure, have rarely exceeded the volume of a nutmeg, so that errors in diagnosis were not out of the question. In the majority of instances the sole results appear to have been amelioration of the suffering, and, in a very few, temporary arrest of growth.

The treatment of carcinomatous diseases by compression, introduced early in the present century by Sir Charles Bell, has, after having been alternately eulogized and condemned, at length fallen into merited disrepute. Many years ago, Mr. Arnott, of London, made an attempt to revive this mode of treatment, especially in carcinoma of the mammary gland, by the invention of a cup-shaped apparatus furnished with an elastic air-cushion, in order to apply the pressure in a more gentle and equable manner. The suggestion, emanating from so eminent an authority, attracted much attention at the time, and led to numerous trials, both in Europe and in this country, but with results so discouraging as to have caused its entire abandonment.

In 1866, Dr. Broadbent, of London, called attention to the treatment of carcinoma by means of the hypodermic injection of acetic acid diluted with two to five parts of water, the quantity introduced at each operation varying from twenty to thirty minims. Cases are cited in which its use is said to have been followed by marked diminution of the volume of the tumor, but as no examples of permanent cure have been reported the practice has been abandoned. I have myself, in the few trials I have made with it, obtained no benefit. In several of the cases the operation was followed by a smart attack of erysipelas and by a good deal of ulceration. The treatment of lymphoma by parenchymatous injections of Fowler's solution is not only attended with depression, restlessness, sleeplessness, and fever, but its employment holds forth no prospect of ultimate recovery.

In regard to extirpation, if it be done early and in a thorough manner, so as to remove all diseased tissues, recent experience has demonstrated that it may be relied upon in a certain proportion of cases as a means of permanent cure. In other cases, the results are not so striking; but there are hundreds of examples of carcinoma, sarcoma, lymphoma, and myxoma on record, which prove conclusively that life may be extended many months and even years by timely interference, and by the removal of recurrent growths as fast as they make their appearance. Hence my conviction is that the knife should be resorted to as early as possible, and that no time should be wasted in the employment of the measures indicated in the preceding paragraphs.

When a sarcoma, or myxoma, is seated in one of the long bones, or deeply among the muscles of an extremity, the only resource is amputation of the limb, performed at the nearest articulation. To remove a limb in its continuity, in such a condition, is worse than useless, conferring neither benefit upon the sufferer, nor reflecting any credit upon the judgment of the surgeon.

Epithelioma is less liable to recur after extirpation than scirrhus, encephaloid, or melanosis. Removed in its earlier stages, there is occasionally a strong probability that there will be either no relapse at all, or only after a considerable period. One reason perhaps of this is that the disease is commonly more localized than the ordinary forms of carcinoma.

General Rules for conducting Excision of Malignant Tumors.—When excision is determined upon, it is very essential that it should be performed in the most thorough and complete manner, in order that the parts may be effectually protected from relapse. The slightest atom of the new tissue, the most minute cell, nay, possibly, the smallest particle of juice, may, if left behind, endanger reproduction.

1st. To accomplish this object, it is necessary that the incisions should be carried through the healthy tissues some distance beyond the morbid growth. If any part has escaped the knife in the first instance, it should be traced out immediately after the extirpation of the main mass, and be excised with the most scrupulous exactness. Free use should be made, in this stage of the operation, of the sponge and finger; of the former for clearing away the blood, of the latter for ascertaining the consistence of the surface of the wound. The sight alone should never be trusted, inasmuch as it is a great deal more deceptive than the sense of touch. Not a particle of the least suspicious substance should be left behind. Nay, the very atmosphere of the disease should be destroyed. Skin, muscle, glands, vessels, nerves, and bone should all be sacrificed, if necessary to success.

2dly. When only a portion of an organ is involved by a malignant growth, the rule is to remove, not a part, but the whole of it. Thus, in carcinoma or sarcoma of the mammary gland, the practice invariably is to extirpate the entire organ, however small the part implicated.

3dly. It is equally important to remove the associated contaminated lymphatic glands, and even search for them if they were not palpable previous to the operation. In carcinoma of the breasts of fat women, laying open the axilla will frequently bring to light infected glands which could not be felt from the surface. If permitted to remain the object of the operation will be defeated.

4thly. The utmost care must be taken to guard against hemorrhage, even when the patient is tolerably plethoric, especially if the operation is at all severe. Lean and fat subjects generally bear the loss of blood badly. A copious hemorrhage, besides seriously endangering adhesive action, is often followed by erysipelas, and I am fully satisfied that it predisposes to early relapse.

5thly. As a preventive against local reproduction the wound left by the operation should be mopped with a strong solution of chloride of zinc, or even seared with the cautery at a red heat. The latter agent is always indicated after the extirpation of secondary nodules in the adjacent muscles.

6thly. The edges of the large wound should be as closely approximated as possible by a few sutures inserted at least an inch from the edges and by adhesive strips. The most suitable dressings are an oiled compress and a bandage. When the parts are slow in healing, skin grafting may be employed.

7thly. When the skin is defective, it is sometimes practicable to borrow the requisite amount from the surrounding structures; an operation first suggested, I believe, by Martinet, who imagined that a return of the disease could thereby generally, if not always, be effectually prevented. He thought the functions of the parts might thus be changed in such a manner as to restore their healthy nutrition, and so counteract the tendency to the reproduction of carcinoma.

I have had recourse to this procedure in a number of instances, in different regions of the body, especially in epithelioma of the lips and eyelids; but in very few with any permanent or even protracted benefit. For a time the transplanted parts retained their healthy character; but at the end of a few months they gradually became hard and rigid, and soon thereafter exhibited all the evidences of carcinomatous disease.

8thly. When the morbid growth is seated in an extremity, and is of large bulk, or involves important structures, amputation takes the place of excision. Whenever the operation is performed for sarcoma of the long bones, experience has shown that there will be no return of the disease in the stump, provided care has been taken to remove the limb above the limits of the tumor. Death, however, commonly occurs, except when the sarcoma is of the myeloid variety, at no distant date from a development of similar disease in some of the internal organs, especially the lungs.

Finally, it is well to bear in mind that the surgeon, in the removal of a malignant tumor, may incur great personal risk as it respects his own health and life. Professor Dudley suffered for many months from the inoculation of his hand in amputating the forearm of a person affected with encephaloid sarcoma; and, in 1869, Dr. Maurice H. Collis, of Dublin, lost his life from the effects of a slight puncture of one of his fingers, received during the excision of a carcinomatous tumor of the upper jaw. Other examples of a similar nature are upon record. The symptoms are usually those of blood poisoning. Thorough ablutions, first with simple water and soap, and then with water impregnated with chlorinated sodium, are the best preventives.

Treatment after Operation.—The treatment after removal of the affected structures must be conducted upon general principles. When the patient has recovered from the immediate effects of the operation, he should be put upon a general course of treatment intended to maintain his health as near as possible at the normal standard. Above all, strict and constant attention should be bestowed upon his diet.

Of the propriety and importance of attention to the patient's diet, after excision, no one can entertain any doubt. The force of this remark will appear the more evident when it is recollected that the progress of carcinoma has occasionally been stayed for months, and even years, by a regular and persistent system of starvation, barely allowing a sufficient quantity of food, of the most bland and unirritant character, to maintain the due play of the vital functions, without too great a reduction of the heart's action.

The kind of diet is a matter of no little moment. Meats, soups, and the coarser varieties of vegetables should generally be proscribed, on account of their heating and indigestible character. For the same reason, condiments, wines, spirits, coffee, and fermented liquors are to be eschewed. Among the more suitable articles are stale bread, toast, and soda biscuit, hominy, grits, rice, sweet and Irish potatoes, mush, macaroni, baked apples, figs, and ripe fruits. Oysters and fresh fish may be used in moderation. Not only

should the food be perfectly simple, and easy of digestion, but it should be well masticated, and taken in such quantity at each meal as not to crowd and oppress the stomach.   As drinks, the best articles are water, milk, and weak tea.

Of late years an almost exclusive milk diet has been used in several remarkable cases after this operation, with effects so encouraging as to deserve further trial.   The facts published upon this subject by Dr. Pierce, Dr. Bowditch, and others, are exceedingly interesting and instructive, and worthy of attentive consideration.

As there are no remedies which will eradicate the malignant structure from the system before the operation, so are there none which will prevent its reproduction after. Of the numerous articles that have been employed for this purpose there is not one which can be viewed in the light of a specific, or as a counter agent to the morbid action.

Some of the older surgeons, and, indeed, quite a number also of the modern, strongly insist upon the establishment of a kind of perpetual drain in the neighborhood of the original disease, as a means of preventing relapse after extirpation.   The principal measures that have been suggested for this purpose are the issue and seton ; modes of treatment with which I have no experience, and in which, on principle, I should have no confidence.

If relapse ensues, and the patient becomes debilitated, supporting measures must be adopted, as quinine, iron, brandy, and nutritious food, along with gentle exercise in the open air.   Pain must be allayed by the free use of anodynes, and night sweats by sulphate of atropia, elixir of vitriol, or oxide of zinc, given in as large doses as the stomach will tolerate.   Constant attention must be paid to cleanliness ; fetor must be corrected by chlorinated sodium, permanganate of potassium, and other means ; and the utmost care must be taken to protect the parts from the pressure of the clothes and from all kinds of rude contact.   The most suitable local remedies are leeches, dilute tincture of iodine, opiate plasters, and emollient cataplasms, medicated with anodynes.

Contraindications to Surgical Interference.—The following circumstances may be enumerated as contraindicating the removal of malignant tumors :—

1st. Interference should be avoided when the disease coexists in several parts of the body, as, for instance, in the mamma and uterus, or the testicle and eye, as it would be almost certain to hasten the patient's destruction.

2dly. No operation is ever resorted to, at least not as a curative agent, when there is serious local involvement ; or when there is marked evidence of the carcinomatous cachexia. Thus, in carcinoma of the mamma, no surgeon who values his reputation, or who has any regard for the welfare of his patient, interferes when the tumor is firmly adherent to the surrounding parts, when the skin is changed in structure, ulcerated, indurated, or dimpled, when there is enlargement of the axillary, subclavicular, or supraclavicular lymphatic glands, when there is œdema, with numbness and loss of function in the corresponding limb, and, finally, when, in addition to these symptoms, the countenance exhibits all the evidences of the carcinomatous cachexia.   The same circumstances guide the surgeon in carcinoma of the testicle, lip, penis, and extremities.   If the knife is ever employed when the malady has made such progress and such inroads, it is with a view solely to palliation, not to cure.   Of the propriety of such a course every surgeon must be his own judge.

3dly. When the disease advances very rapidly, as it not unfrequently does in encephaloid sarcoma, carcinoma, and myxoma, breaking through its original barriers, and leaping, as it were, suddenly into the surrounding tissues, ablation will either be improper, or, if had recourse to, speedy repullulation may be expected.   Rapid growth, constituting what has sometimes been denominated the acute form of malignant action, always implies a bad state of the constitution and extensive infiltration of the surrounding tissues, and imperatively forbids surgical interference.   An œdematous appearance of the parts immediately around the morbid deposit, or at a distance more or less remote from it, is another unfavorable occurrence.   This condition, which is seldom absent in external carcinoma in its later stages, is not unfrequently present at an early period in encephaloid, especially in the hematoid variety, and is always indicative of the very worst state of things, both local and constitutional.   The immediate cause of this symptom is obstruction of the lymphatic vessels and glands.   Observation shows that nothing but mischief is to be expected from interference when the malady has attained this crisis.

4thly. A quickened state of the pulse, occasioned by the local irritation, augurs unfavorably.   Excision, performed under such circumstances, is nearly always speedily followed by relapse.

5thly. Latent carcinomas should not be tampered with.   Cases constantly occur in which, from neglect of this precaution, the patient loses his life, within a very short period

after operation, from a return of the disease in its worst form. The reproductive powers of the part, if not of the system generally, usually manifest an astonishing activity under such circumstances, and the consequence is that the malady soon accomplishes its work of destruction.

6thly. It is not necessary to insist upon the propriety of refraining from operation when there is serious disease of an important internal organ. Such a complication could hardly fail to predispose to relapse, if not to the speedy destruction of the patient.

7thly. I was formerly greatly opposed, in malignant affections, to operative interference merely as a palliative measure, believing that the pain and risk consequent upon its employment, would not counterbalance the beneficial effects. After more mature experience, however, I came to a different conclusion, and for years past I have, in numerous instances, used the knife where there was not the slightest prospect of a permanent cure. The class of cases to which this procedure is more especially adapted are those in which there are excessive pain, loss of appetite and sleep, and great discharge of foul, offensive matter, contaminating the air of the patient's apartment, and rapidly undermining the vital powers. With the aid of anæsthetics, an operation is no longer a source of suffering, and may, in such a condition, if properly performed, be followed by much good, not only freeing the patient from local and constitutional distress, but, perhaps, materially prolonging life by getting rid of a burden which has weighed down both mind and body. Moreover, the recurring disease is not always as bad as the original, although such an event can seldom be foretold with any degree of certainty.

Reproductive Tendency of Malignant Diseases after Operation.—Of the reproductive tendency of malignant diseases, after extirpation, or destruction by the actual or potential cautery, writers have made mention from the earliest periods of medical science to the present time. Hippocrates was fully aware of the fact; and he entered his protest against all operative proceedings, under the conviction that, however early or well executed, they could not possibly afford any permanent relief, or protect the patient against a return of this malady. Similar views have been advanced by nearly all succeeding writers; but a different sentiment is now entertained in regard to removal as a final measure in many cases, provided early and adequate operations are performed.

The period at which relapse occurs varies from a few weeks to several years, the average period being from four to six months. Occasionally it is astonishingly short. In one of my cases relapse appeared in less than three weeks. The original disease, a genuine scirrhus of eight months' standing, occupied nearly the whole of the left breast; the nipple was somewhat retracted, and there was a slight enlargement of one of the lymphatic glands of the axilla, which was removed in the operation. The dissection was performed with the utmost care, and the wound united by the first intention, excepting a little spot at the centre, which remained open and became the starting-point of the new growth. The woman, who was forty-six years of age, died three months after the operation, having endured the most horrible suffering.

When relapse is unusually tardy, the probability is that the original disease was more than ordinarily localized, and that there is no disposition after extirpation to involvement of the general system.

All malignant diseases possess a tendency to relapse after ablation, although not in an equal degree. Encephaloid undoubtedly has it in a far greater degree than scirrhus, and scirrhus than colloid. Melanosis also recurs with great frequency and promptness, and may be placed next to encephaloid in this respect. Even epithelioma often relapses after extirpation, but now and then the part and system continue to be remarkably exempt for years, if not during the remainder of life. Sarcoma, myxoma, and lymphoma also evince a great tendency to local reproduction, the last, indeed, being scarcely inferior in that respect to encephaloid carcinoma.

The reproductive tendency of malignant disease, after operation, is well illustrated in the case of a man, aged thirty-two, who consulted me in April, 1851, on account of a sarcomatous epulis of the lower jaw, first noticed three months previously. The growth was firm, elastic, free from pain, of a pale red color, and attached to the gum and jaw, extending from the ramus to the first bicuspid tooth. Two operations had already been performed upon it, each being followed by rapid relapse. On the 27th of April, I excised the parts, along with the corresponding portion of the jaw. On the 24th of September the patient came again under my care, and I now removed the whole of the new growth, about the size of a pullet's egg, and also about three-quarters of an inch of the anterior extremity of the ramus of the bone, from which the diseased structure seemed to spring. On the 31st of August, 1852, I excised the ramus at the articulation, the disease having

attacked its inferior extremity.   The man remained well until the winter of 1853, when the disease broke out in front of the ear, where it soon formed a tumor as large as a small fist, under the effects of which he rapidly sank.   It is worthy of remark that the general health had all along been pretty good, and that the wound always healed well after each operation.

Epithelioma affords a greater number of non-recurring examples after operation than any other carcinomatous formation.   I have myself had a number of instances of epithelioma of the lip in which there was an entire freedom from disease for years—in some as many as seven, eight, and even ten—and similar good luck has followed some of my excisions of the penis for carcinoma of the head of that organ.   In a case of epithelioma of the lower lip, communicated to me by Dr. Barclay, of New York, the patient survived the first operation seven years, the knife having been employed altogether five times.

In a case of encephaloid sarcoma of the thigh, reported to me by Dr. C. S. Tripler, of the Army, the man did not die until five years after the first operation.   In 1853, I amputated the arm of a gentleman, thirty-five years of age, on account of soft sarcoma of the upper portion of the forearm; the disease had been in progress for nearly twelve months; the tumor was large and well-marked; the wound healed kindly, and life was prolonged for nearly six years, when death occurred from some affection of the lungs and pleuræ, the precise nature of which I have not been able to ascertain.   I am acquainted with the history of a number of other examples nearly equally remarkable.

The recurring tendency of melanotic sarcoma is familiar to every surgeon of experience. Hardly an example of permanent cure by operation is upon record.   A remakable instance of this recurring action came under my notice many years ago, in the practice of the late Professor McClellan, of this city.   The disease had, seemingly, begun in several small subcutaneous tubercles of the abdomen, about the size and color of so many shot, which soon became exquisitely painful, and, gradually bursting through the skin, were at length converted into foul, fungous sores, attended with a highly fetid, sanious discharge.   Many of these tumors were extirpated, some in their crude, others in their open state; but, although the wounds generally readily healed, they were always rapidly succeeded by a new growth in the immediate vicinity of the original.   The man became much emaciated, and finally died completely exhausted, with all the evidences of the melanotic diathesis.

CHAPTER VIII.

SCROFULA AND TUBERCLE.

The term scrofula had formerly a far more limited application than is at present accorded to it.   It was originally employed to designate a glandular swelling of the neck, strikingly resembling the neck of the swine, whence its derivation.   At present, however, it has a much wider signification, including within its range a variety of affections apparently of the most opposite character, and yet in reality essentially alike in every particular.   As meaning the same thing, the words struma and tubercular disease are frequently used.

The affections which may be comprised under this term are pulmonary phthisis, chronic enlargement of the glands of the neck and other parts of the body, hip-joint disease, psoas, lumbar, and chronic abscesses, Pott's disease of the spine, certain forms of follicular ulceration of the mucous membranes, arachnitis, otorrhœa, ozæna, ophthalmia, eczema, and ulceration of the bones.   The fact is, the class of scrofulous maladies is almost endless; for they affect almost every part of the body, and assume almost every form of morbid action.

Scrofula consists essentially of a peculiar state of the system, in which there is a marked tendency to the formation of an inflammatory product known by the name of tubercle.   Attempts have been made from time to time to draw a distinction between tubercle and the state of the system which predisposes to its occurrence.   It is difficult altogether to deny the propriety of this distinction; for there are unquestionably cases which we are in the habit of designating as strumous, where, nevertheless, there is not, so far as can be determined, the slightest tubercular deposit.   There would seem to be

merely a strumous irritation in the part, without the part being in a condition to furnish any product capable of giving rise to tubercles.

There is another distinction, which, however, is fast losing ground, which it is more difficult to reconcile than that just mentioned, the alleged difference between phthisis and scrofula. It would be easy, if a work on surgery were the proper place to discuss the subject, to show the fallacy of this opinion. I have long been convinced of the identity of these diseases, and of the fact that the only actual difference between them depends, not upon any difference in the morbid action, but solely upon the difference of structure, tubercular disease sharing the same fate, in this respect, as ordinary inflammation and as the other atypical formations. A tubercle in the lung is essentially the same disease as a tubercle in a bone or a lymphatic gland, having a similar origin, running a similar course, and producing similar results.

Tubercular disease is of an infectious nature, and is due to the absorption of the softened caseous products of scrofulous inflammation, which excite irritation and proliferation of the cellular elements with which they come in contact, and in that way result in the formation of the tubercle granule. Once formed, submiliary tubercles increase by aggregation, and by their caseous degeneration and softening may act as foci for secondary infection.

The transmissibility of tubercle by inoculation has been confirmed by the experiments of Villemin, Cohnheim, Burdon-Sanderson, and other investigators, and there is reason to believe that tuberculosis may be communicated in the human subject in other ways. Thus Reich has recorded some interesting observations which show that the disease was transmitted by a phthisical nurse to a number of children ; and the risk of contracting the affection by occupying the same bed with a subject of pulmonary consumption, is insisted upon by several authors. Tuberculosis has been produced by feeding the lower animals on tuberculous material ; and Epstein believes that the disease may be transmitted to children by the ingestion of the milk of tuberculous nurses and cows.

Tubercular disease occurs at all periods of life. Sometimes, indeed, it exists as an intra-uterine affection, thus leading to the conviction that it is occasionally hereditary, or that it is transmitted in the very act of impregnation. When it occurs as phthisis, it is most common between the twentieth and fortieth year, and it is remarkable that after the age of puberty it rarely exists in any part of the body without involving the lungs. In children, the disease, considered in a general point of view, is most frequent between the third and tenth year. A vast majority of the cases of scrofulous disease that are met with in the form of coxalgia, Pott's disease, caries of the short bones of the extremities, arachnitis, ophthalmia, otorrhœa, tonsillitis, and chronic enlargement of the lymphatic glands, occur at this period of life, and constitute an immense source of mortality. It is a remarkable fact that adults seldom suffer from external scrofula ; and, on the other hand, it is equally remarkable that children suffer comparatively seldom from consumption, so common among persons after the twentieth year. In old age the disease is rarely witnessed in any form.

Struma is frequently hereditary. The children of consumptive parents are often cut off by the same disease, or they suffer in various parts of the body, as the bones and joints, lymphatic glands, eye, ear, and serous membranes. Whole families are sometimes swept off by it. Occasionally the disease skips one generation, and reappears in another, owing, doubtless, to some temporary improvement in the intermediate offspring.

Tubercle has been observed in nearly all the organs and tissues of the body, the only ones, perhaps, that are exempt from it being the skin, nerves, ligaments, aponeuroses, tendons, and voluntary muscles. The lungs, particularly their summits, are, of all the structures, the most prone to suffer ; then, next in the order of frequency, come the lymphatic glands, then the spleen, serous membranes, and mucous follicles of the alimentary canal, then the bones and joints, and finally the brain, liver, kidneys, testes, and false membranes of the serous cavities. In the lungs and some of the other more vascular organs the external coat of the smaller bloodvessels seems to be the favorite seat of the deposit. Its coexistence in various parts of the body, or its almost universal diffusion, is sufficiently common, and constitutes the so-called strumous diathesis.

The deposit being the result of an infectious inflammatory process, and due to the proliferation of the endothelial cells of the bloodvessels, lymphatics, and of the serous membranes, of the fixed connective-tissue corpuscles, and of the wandering cells, occurs both in the parenchyma and upon the free surfaces of the organs. Hence it exhibits itself in various forms, of which the nodular is by far the most common, the stratiform and infiltrated being, indeed, exceedingly rare. The nodular variety occurs in little masses, from

the size of a millet-seed to that of a pea, of a pale yellowish or grayish color, and of a consistence ranging from that of curds or soft putty to fibro-cartilage, hundreds and even thousands often existing in a very small compass. When very numerous and closely grouped, they sometimes coalesce, so as to form a tumor of considerable size. The stratiform variety of the deposit is most common upon the mucous surfaces, while the infiltrated is met with chiefly in the lungs, around tubercular excavations, and in the lymphatic glands. Whatever shape it may assume, it is always deposited in a soft state, from which however, it passes speedily into the solid form, which it retains for a certain period, generally from six to twelve months, when, becoming softened and disintegrated, the part makes an effort to rid itself of it. These changes are followed by the formation of a cavity, named a strumous abscess, of which the best examples occur in the lungs, bones, and lymphatic glands. The matter is peculiar, being generally of a yellowish, dirty, turbid color, thin, oleaginous, and intermixed with small whitish flakes, very similar to broken-down grains of boiled rice.

Tubercles present certain peculiarities in their histological characters in accordance with their age and the structure of the organ in which they originate. They are, however, usually composed, as is well represented in fig. 73, from Green, of a small-celled lymphoid tissue surrounding giant or multinucleated cells, the branched processes of which are continuous with the adenoid reticulum. The cells contained within the reticulum are round or ovoid, and vary in size from $\frac{1}{2500}$ to $\frac{1}{3500}$ of an inch in diameter. An isolated giant cell with its long processes is shown in fig. 74, copied from the same author.

Fig. 73.   Fig. 74.
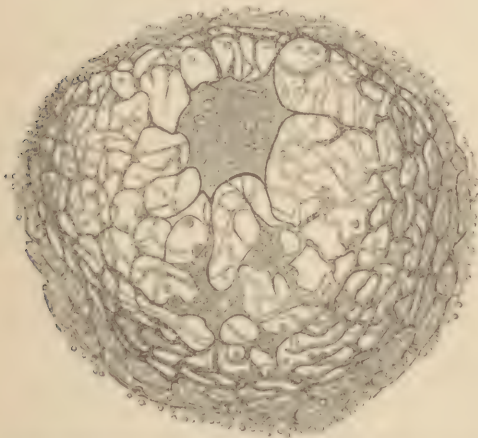
Minute Structure of a firm Gray Miliary Tubercle of the Lung in a Case of Acute Tuberculosis.   A Multinucleated Cell from the Lung in a Case of Chronic Phthisis.
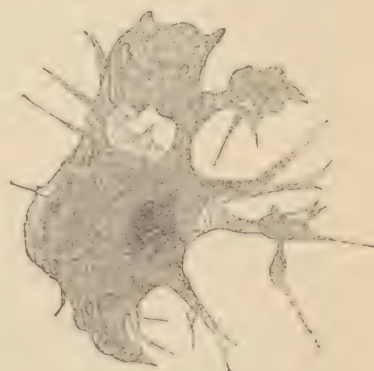
Tubercular material, in its crude state, consists almost entirely of albumen, with a small quantity of earthy salts, particularly phosphate and carbonate of lime. Some specimens also contain a little fibrin, casein, extractive matter, and pyine; but the great and pervading substance is albumen, or protein matter.

The microscopical and chemical examinations of tubercle are extremely valuable, inasmuch as they go to show the low grade of its vitality, and its consequent inability to maintain, for any length of time, its existence. The vessels of the tissues in which the new formation originates gradually become obliterated, and, as a result, the nodule undergoes caseous degeneration, which ends in softening and the production of a cavity or an ulcer. Now and then, and particularly when the fatty degeneration is not so marked, the adenoid reticulum is converted in a firm fibroid mass; and dessication and calcification of the caseous material are occasionally met with.

Of the exciting causes of tubercular disease our knowledge is rather conjectural than positive. It may fairly be inferred, however, from the numerous observations that have been made upon the subject, that, when the tendency to the disease exists, anything that produces excessive debility, or an impoverished condition of the blood and solids, may provoke the morbid deposit. The causes which are most likely to bring about this effect are: 1. Meagre and unwholesome food, deficient in fibrinous, albuminous, gelatinous, and fatty qualities. 2. Protracted disorder of the digestive organs, particularly the various

forms of dyspepsia. 3. Exposure to cold, and confinement in damp, ill-ventilated, ill-lighted apartments. 4. Exhausting fevers. 5. Excessive and long-continued evacuations of blood. 6. Severe courses of mercury. 7. Stoppage of habitual discharges, as the menstrual and hemorrhoidal. 8. Protracted mental depression. 9. Syphilis, whether original or inherited. 10. Inordinate sexual indulgence. All these causes act by lowering the vital principle, and diminishing the plastic properties of the blood.

The immediate cause of the disease is inflammation, which regulates not only the quantity, but also the quality, of the deposit. The action is generally of a low grade, and is therefore not characterized by the ordinary phenomena, although it is not the less effective on that account. The reasons which may be adduced in support of this view are the following :—

1. Irritation of the lung, mechanically excited, frequently gives rise to tubercle in that organ, as is occasionally seen in cases of foreign bodies, accidentally introduced through the larynx. In the inferior animals, as the dog and the rabbit, mercury dropped into the trachea often rapidly induces the disease. Miners, needle-grinders, and weavers, habitually exposed to the inhalation of gritty and irritating matter, are particularly prone to phthisis.

2. This view of the origin of the disease is countenanced by the composition of the deposit; for we know of no substance which contains so much albumen, or albumen and fibrin, that is not the product of inflammation.

3. Tubercle bears a great resemblance to lymph, especially the more degraded forms of that substance, and this, as every pathologist is aware, is always the result of inflammatory action.

4. The disease is often developed under the immediate effects of cold, and various other causes which have a tendency to produce congestion of the internal viscera. Indeed, it is well known that dyspeptics, and persons who live upon unwholesome food or in damp and ill-ventilated apartments are peculiarly liable to suffer from this disease.

A close and careful study of scrofula during a half of a century in public and private practice has forced upon my mind the strongest conviction that many of the so-called cases of the disease, as they are brought under our observation, are simply examples of a syphilitic taint of the system in its more remote forms. The influence of the syphilitic poison in establishing a cachectic state of the constitution, and thus deteriorating the blood and solids, has long been recognized, if, indeed, not universally acknowledged, by professional men. A poison like this, so potent, so subtile, so diffusive in its action, and so difficult to eradicate, is well calculated to make the most fearful inroads upon the system, pervading every atom of living matter, weakening the vital powers, and establishing a predisposition to disease, which the slightest causes may readily fan into an open flame. What adds still further to this deterioration of the blood and solids is the harsh and unscientific treatment still so frequently employed, even at the present day, in the different forms of syphilis. Mercury, especially calomel, it is true, is no longer used in the copious and reckless manner so characteristic of the practice of former times. Syphilitic patients are no longer salivated until the tongue protrudes from the mouth, the teeth shake in their sockets, and quarts of saliva are discharged in the twenty-four hours, week after week, draining and exhausting the system, and producing a state of debility often only ending with life itself. The effect of this improved method of treatment has been a marked diminution of the so-called scrofulous affections. Forty years ago strumous disease of the neck was much more common than it is now. At present we seldom meet with those large, hideous glandular swellings, the flattened nose, the deformed palate, and the cadaverous-looking countenance, at that time so frequent, especially among the lower orders of persons, the victims of the joint agency of the syphilitic poison and of injudicious mercurial medication. Such cases have become comparatively rare, at least in this country; and still further improvement may reasonably be anticipated from steady perseverance in the present system of treatment, especially from the use of the iodides in the tertiary form of the disease.

The duration of strumous diseases is too variable to admit of any accurate general statement. Phthisis usually destroys life in from nine to eighteen months; tubercular arachnitis often terminates fatally in a few days; while external scrofula may last for years, and finally eventuate in recovery.

The symptoms vary, of course, according to the nature of the affected structure; but, whatever this may be, there are certain appearances which are hardly ever absent in any case. Thus, whether the disease be seated in the lungs, in a bone, in a joint, or simply in the connective tissue, in the form of a cold abscess, there is always, during its progress,

excessive emaciation; for, with the exception of the glandular viscera, the brain, nerves, and a few other parts, there is hardly any organ in the body that does not, in some degree, participate in the general atrophy. The fat gradually but surely disappears; the muscles are pale, flabby, and attenuated; the connective tissue is deprived of its moisture; the skin is soft and blanched; the hairs grow slowly, and many drop out; the nails are thin, and frequently incurvated; and the bones, although they retain their size, are usually light, and saturated with sero-oleaginous fluid. The blood also is altered. It is impoverished, thin, pale, and deficient in red globules. The clot is unnaturally small and dense, and when the disease is fully established, with a tendency to suppuration, is almost always covered with a buffy coat. The fibrin is not materially changed until softening sets in, when it increases disproportionately in quantity, and so continues until suppuration begins, when it attains its maximum. These alterations are generally very conspicuous in phthisis, psoas abscess, and extensive disease of the lymphatic glands.

Persons who are affected with scrofula, or who are laboring under what is termed the strumous diathesis, exhibit certain peculiarities which may be considered as almost characteristic. These refer mainly to the state of the complexion, the digestive apparatus, and the circulation.

The complexion is generally brunette, and the hair, for the most part, dark, although in both these respects the greatest possible diversity exists. The eyelashes are drooping and of extraordinary length; the pupils are habitually dilated; the upper lip is tumid; the face is pale and puffy; the hands and feet are nearly always cold; the body is unusually impressible by atmospheric vicissitudes; the abdomen is hard and distended; there is a deficiency of muscular strength; and the intellect is dull and sluggish, instead of being sprightly and precocious, as is usually represented. The digestive organs are subject to frequent derangement; the appetite is irregular and capricious; the bowels are either constipated or relaxed, seldom entirely natural; digestion is feeble and imperfect; great annoyance is experienced from flatulence and acidity; and the individual is often a martyr to dyspepsia. Children predisposed to struma are particularly prone to cutaneous eruptions about the scalp, to purulent discharges from the ears, and to chronic enlargement of the tonsils and lymphatic glands.

There is another class of strumous subjects of a state of mind and body almost the opposite of that just described. The complexion is light and florid, the eye blue, the mind unusually active, and the cutaneous circulation very vigorous. The parts of the body which are most liable to suffer, in this form of constitution, are the bones and joints, the eye, skin, and lymphatic glands, particularly those of the neck, consumption being much more rare than in the dark variety.

Scrofulous Ulcer.—Various scrofulous affections of the skin give rise to ulceration, but, perhaps, the most characteristic ulcer of this kind is that consequent upon suppuration of the lymphatic glands of the neck, groin, and axilla. Be this as it may, the features of the scrofulous ulcer are so peculiar as to require distinct notice.

The surface of the scrofulous ulcer is always unhealthy, being coated with rough, aplastic matter, of a pale yellowish or grayish color, hard, and firmly adherent to the subjacent structures. This matter, which possesses none of the characteristics of laudable pus, is often intermixed with disintegrated tubercular substance. In many cases the bottom of the ulcer is formed by altered lymphatic glands, of a reddish appearance, and so much softened as to break down under the slightest pressure; sometimes, however, they are hard, almost of a fibrous consistence, and as if they had been partially dissected from the surrounding parts. In some cases, in fact, they separate, or slough, several perhaps coming away at the same time, or in more or less rapid succession. No healthy granulations exist upon such a sore, unless it is in a healing condition, and even then they form and maintain themselves with great difficulty.

The edges of the ulcer are characteristic. They are of a bluish, purplish, or reddish hue, undermined, hard, jagged, thin and sharp at some points, thick and obtuse at others. Occasionally they are bent in towards the bottom of the ulcer. They are generally remarkably insensible, deeply congested, and incapable of forming healthy granulations. In fact, the skin, having lost its support, is excessively impoverished, and has great difficulty in maintaining its vitality.

The structures around the scrofulous ulcer are generally hard, either from the presence of indurated and diseased glands, or from interstitial deposits; usually, in fact, from both. The skin is red and congested, and not unfrequently also somewhat œdematous, pitting on pressure. The swelling is often great and disfiguring; in short, characteristic of that peculiar appearance from which the disease originally derived its name; the neck, when that is the part affected, strikingly resembling that of the swine.

The scrofulous ulcer may be single, or multiple; variable in shape and extent, and frequently communicating with considerable sinuses. The discharge is ichorous, or thin and whey-like; sometimes thick and yellowish; in either case, apt to be intermixed with the debris of distintegrated glands, flakes of lymph, and broken-down tubercular matter.

The cicatrice left by the healing of a scrofulous ulcer is peculiar. It is of a fibroid texture, very hard, dense, almost crisp, and tightly adherent to the subjacent structures. Its surface is of a purplish hue, more or less depressed, traversed by large veins, and marked by prominent radiating ridges. The surrounding skin is hard and contracted, very much as in the scar of a burn. A long time generally elapses before the new skin becomes soft and pliant, and divested of its unnatural complexion.

Treatment.—The treatment of scrofula, like that of carcinoma, has been exceedingly diversified and empirical, for there is hardly a solitary article of the materia medica that has not, at one time or another, been called into requisition. Even at the present day, when the pathology of the disease is so much better understood, the greatest uncertainty prevails in regard to our therapeutic measures, and the consequence is that few practitioners approach the disease without doubt and misgiving as to the benefit they may be able to confer by their treatment. Strumous affections have always afforded a vast field for the charlatan, and his pretensions have never been more impudently paraded before the public than in our own day. One, if not the chief, reason of this is that so few practitioners really understand the nature of this class of diseases; they seem to forget, or not to know, that they occur in every possible form and under every variety of circumstances, and, that, in order to meet them successfully, it is necessary constantly to vary our remedies according to the exigencies of every particular case. I am certain, from no little experience upon the subject, that the results of our treatment hinge most materially upon a just discrimination of the different states of the system under which these affections occur. To treat every case of scrofula alike, without regard to the condition of the constitution which attends it, is, to say the least, absurd. The disease has no specifics; and I do not hesitate to declare it as my opinion that the indiscriminate use of iodine and cod-liver oil, still so common, has done an immense amount of harm, in so often taking the place of other and more suitable remedies.

It will be sufficient, for practical purposes, to consider scrofulous subjects as being divisible into two great classes, the weak and the vigorous; that is, those who have but little constitutional stamina, and those who, although affected with a strumous taint, are comparatively strong and robust, possessing a ruddy complexion, and an active cutaneous circulation. The latter, undoubtedly, constitute the minority of the cases that come under our observation, but they are, nevertheless, sufficiently common, and so well marked as to be easily recognized by the most superficial observer. Now, to treat these two classes of subjects on the same principle, as is so generally done, is contrary to the dictates both of sound sense and daily experience. While cod-liver oil, iodine, and tonics will perform wonders in the naturally weak, they will be of little avail in dislodging and curing the disease in the naturally robust; and, conversely, while the lancet and tartar emetic will be of immense service in the latter, their employment can scarcely fail to be highly prejudicial in the former. It must not be imagined, however, that one mode of treatment is applicable to every instance of this or of that form of the disease; on the contrary, circumstances constantly arise during the progress of each particular case which imperatively demand a change of remedies, and it is in the knowledge of this fact that the great art of curing the malady lies.

It is well, as a general rule, to begin the treatment with some mild but efficient aperient, to clear out the bowels, and improve the secretions. The course must then be shaped by the peculiarities of the case. If the patient be naturally very feeble, or has become so by protracted suffering, an alterative and tonic course must at once be instituted, as the most likely to meet the indications; but if, on the other hand, he is strong and plethoric, as denoted by the state of his pulse and complexion, much time will be gained, and the structure saved, by the use of antiphlogistics, especially tartar emetic and Epsom salt in the form of the saline and antimonial mixture, properly guarded with tincture of opium. The lancet must be employed with the greatest care; but I am satisfied that it is often of immense benefit in arresting the morbid action, and that it has fallen into too much neglect in the treatment of scrofulous affections. In scrofulous inflammation of the eye, throat, and lymphatic glands, its effects are often marked and permanent. But there is a time when the employment of active measures ceases to be proper, and when they must be superseded by other remedies, similar to those generally applicable in the more common form of the disease. If the depletory system of treatment be carried too far, it

exhausts the vital powers, and thus creates a disposition, in different parts of the body, to deposition of tubercular matter.

Among the various remedies that are employed for the cure of scrofula, iodine may be regarded, in many respects, as the most important. It may be administered alone, or in union with other articles, as potassium, iron, mercury, lead, quinine, barium, and ammonium; and hence much judgment is often required to determine what particular form of it is best adapted to a particular case or form of the malady. As a general rule, it may be stated that, when a purely alterative effect is desired, it may be exhibited by itself, in substance, in tincture, or in the form of Lugol's concentrated solution, consisting of one scruple of iodine and double that quantity of iodide of potassium, dissolved in seven drachms of water. Of this from five to ten drops may be taken every eight hours, in a wineglassful of sweetened water, the dose being gradually increased to fifteen, twenty, twenty-five, or even thirty drops, according to the tolerance of the system.

With the same view, iodide of potassium is not unfrequently administered alone; and, when scrofula is associated with constitutional syphilis, rheumatism, or mercurial disease, it certainly constitutes one of the best forms in which iodine can be exhibited. With whatever intention it be employed, it is proper always to begin with small doses, as four or five grains, if the patient be an adult, gradually increased to ten, fifteen, and even twenty, three or four times a day. The most eligible mode of giving it is in union with some aromatic syrup. Some patients take it very well in hop tea, and when there is much restlessness at night, or nervous irritation, this is perhaps the best form in which it can be exhibited.

When the liver is at fault, when there is a syphilitic taint of the system, or when there is much disorder of the secretions, protiodide of mercury may advantageously be prescribed, in doses varying from the fourth to half a grain, three times a day. The biniodide may be employed with a similar view, but, as it is much more potent, greater caution is necessary in its administration. The dose, which, at first, should not exceed the twelfth or sixteenth of a grain, may be gradually augmented to a fourth or even half a grain, given in the form of pill, or in alcoholic solution.

When an alterant and tonic effect is indicated, nothing can be better than iodide of iron, or iodide of quinia. The former of these articles is one of the most valuable antiscrofulous remedies that we possess, rarely disappointing expectation. In my own practice it has been particularly beneficial in disease of the cervical glands, upper lip, eyes, and joints. I often give it in solution, but more commonly in the form of pill, in union with quinine and opium. If undue vascular action be present, a minute portion of tartrate of antimony and potassium may be added to each dose. In children, who cannot take pills, the best vehicle is syrup of orange peel, or syrup of sarsaparilla.

Iodide of quinia has been advantageously employed in the treatment of scrofulous tumors, in cases where iodine and tonics are indicated, in doses of one to two grains every six or eight hours.

In whatever form iodine is used, whether as a simple or compound, it must be borne in mind that the system should be free from all vascular excitement, and that, after it has been exhibited for a fortnight, it should be pretermitted for several days, when it may be resumed, and given as before. Employed in this manner, it exerts a much happier influence upon the progress of the complaint, and is much less likely to disagree with the stomach and bowels, than when given uninterruptedly. If it acts as an irritant, it must be administered in smaller doses, or in union with opium or hyoscyamus. Great mischief often results from neglect of this precaution.

Barium is another remedy of great value in the treatment of scrofulous disease. It has repeatedly succeeded in my hands when other means have proved inefficient or entirely unavailing; it is particularly serviceable in chronic enlargement of the cervical glands, both before and after the establishment of suppuration. It is chiefly adapted to patients with a languid circulation, a pale, tallow-like complexion, a flabby tongue, indigestion, and cold extremities. Its use is contraindicated when there is inflammatory excitement, or congestion of any important organ. The best mode of administration is the officinal solution of the United States Pharmaropœia, beginning with six or eight drops, and gradually but cautiously increasing the dose to ten, twelve, or fifteen, three times a day, in a wineglassful of hop tea, or half an ounce of syrup of orange peel. Exhibited in large quantities, it is liable to cause nausea, heartburn, diarrhœa, griping, headache, rigors, profuse sweats, and symptoms of mineral poisoning.

Iodide of barium, from its great alterative properties, is worthy of trial in scrofulous affections. The dose is one-eighth of a grain thrice daily, gradually increased to four, five, or even six times that quantity.

Calcium is sometimes employed with advantage, either in the form of iodide or the solution of the chloride, the dose of the former being half a grain, and of the latter from fifteen to thirty drops, three times a day. The medicine is particularly valuable in the treatment of scrofulous affections of the skin and lymphatic glands.

Bromide of iron occasionally answers a good purpose, although, in general, it is very decidedly inferior to the iodide. The best formula is that of Parrish, the average dose of which, for an adult, is twenty drops every eight hours, gradually increased according to the tolerance of the stomach.

There is no medicine which has been more frequently or more extensively employed in the treatment of strumous diseases than mercury. The preparations most commonly selected are calomel, blue mass, corrosive sublimate, and the black sulphuret, or Ethiops mineral. Of these the bichloride is the best. It should be given in minute alterative doses, as the tenth, sixteenth, or twentieth of a grain, three times a day, either in the form of pill, or solution. Thus administered, it yields hardly in efficacy to iodine, and is probably superior to barium. In employing mercury, in any form, care should be taken that the system is properly prepared for its reception, and that it is not carried so far as to induce salivation. If it be found to act as an irritant or excitant in any way, it must at once be discontinued, or exhibited in smaller quantity. Whether mercury produces its beneficial effects merely by correcting the secretions, and thereby improving the general health, or by suspending or modifying the tubercular action, is still a mooted question.

When the disease has existed for a considerable length, and especially when it is accompanied by marked emaciation, great pallor of the countenance, cold extremities, and a small, frequent pulse, great benefit may be expected from the use of cod-liver oil, given in doses of one drachm to half an ounce thrice in the twenty-four hours, in good ale, or along with a little brandy. The value of this remedy is fully borne out by the general testimony of the profession. Although it contains a minute quantity of iodine and bromine, its good effects probably depend chiefly upon its nutritive qualities. However this may be, it unquestionably improves the condition of the digestive organs, and acts slightly upon the urinary and cutaneous secretions. To derive full benefit from it, its use must be continued for a long time, with an occasional intermission, to afford the stomach a short respite, and to prevent the disgust which must necessarily arise from such a remedy when too persistently administered. Experience has shown that cod-liver oil is of no benefit whatever, in this affection, when there is no decided waste of the system, and when the pulse is rather retarded than accelerated.

Whatever remedies may be employed, the closest attention should be paid to the bowels, diet, exercise, and dress. Constipation is counteracted by mild aperients, as blue mass and rhubarb, or, when there is much disorder of the secretions, by a few grains of calomel, followed by a little oil. Active purgation, however, must be studiously avoided, as it will inevitably do mischief by inducing debility. Torpor of the liver must be promptly met by mild mercurials, and acidity by alkalies, of which bicarbonate of sodium, either alone, or in union with a little ginger, is the most valuable. The alkalies were at one time much in vogue in the treatment of scrofula, in the belief that they possessed a kind of specific power, but their influence was evidently much overrated. Emetics are occasionally of service, especially when there is much nausea, depraved appetite, flatulence, and headache.

The diet of a scrofulous patient should be light, unirritant, and nutritious. It should consist principally of the farinaceous articles, with milk or weak tea at breakfast and supper, the latter of which should always be very light, and taken at least three hours before retiring to bed. Coffee, fresh bread, pastry, and, in short, everything of an indigestible nature, must be proscribed. The food should be well masticated, and never used in such quantity as to oppress the stomach. When the strength is much impaired, some of the lighter meats, a little fresh fish, or a few oysters may be taken twice a day, along with a glass of porter, ale, sherry, port or madeira, or, what is better than all, brandy and milk. Sometimes an almost purely animal diet agrees best with the stomach. Many patients are greatly benefited by the free use of whiskey, rapidly becoming strong and fat under its influence. It should be taken repeatedly in the twenty-four hours, in quantities suited to the state of the stomach and system.

As an important auxiliary, exercise claims particular attention. It may be taken on foot, in a carriage, or on horseback, as may be most convenient or agreeable to the sufferer, and should be indulged in whenever the weather admits of it, without being carried to fatigue. In bad weather, the patient may use dumb-bells, or amuse himself in sawing

wood, planing, or anything else to which he may have access. Children should be carried about in their nurses' arms, or in handcarts.

The patient's clothing is worthy of special consideration. He must be warmly clad. Flannel should be worn next the surface, both in summer and winter, the feet should be protected with thick shoes and stockings, and the skin should be maintained in a healthy, perspirable condition by frequent ablutions with tepid water, impregnated with common salt, ground mustard, strong soap, or any other exciting substance.

A change of air is sometimes of vast service, and has been known to be of itself almost sufficient to effect a cure in this disease. The locality selected should be as healthy as possible, and not liable to great or sudden variations of temperature. If the atmosphere be dry, it matters little whether it be cold or warm, provided it do not run into either extreme. A residence near the sea-shore is often of immense benefit; and daily sea-bathing, in the hot summer months, has occasionally produced the most astonishing improvement in the general health.

In the latter stages of the disease, when the patient is harassed with hectic fever and diarrhœa, the treatment must be of a tonic and stimulant character. The diet must be highly nutritious; porter, ale, wine, and milk-punch must be freely used; the bowels must be restrained with astringents; the excessive sweats must be controlled with quinine, elixir of vitriol, or atropia; and sleep must be procured and pain allayed with anodynes.

There is no doubt that the state of the mind is capable of exercising a powerful influence upon the cure of scrofula, especially when seated in the external parts of the body. This may be assumed to be a fact from the astonishing benefit which so often followed the royal touch, a practice which originated in the time of Edward the Confessor, near the middle of the eleventh century, and which continued down to the reign of Queen Anne. The belief in the efficacy of the royal touch seems to have been for a long time almost universal in Britain. It was particularly prevalent in the reign of Charles II., who, in one single year, touched nearly 100,000 persons, who flocked to him from all parts of England, Ireland, Scotland, Jersey, and Guernsey. The practice was generally accompanied by prayers and other religious ceremonies, and particular days and seasons were set apart for its observance. The effect of this singular remedy was variable; in some of the patients a cure followed almost immediately after they were touched; in others, the relief was more tardy, but in the end not the less effectual; occasionally the process was obliged to be repeated; and in some cases the treatment was entirely useless. Richard Wiseman, who was surgeon to Charles II., and a most sagacious observer, must have had great confidence in the efficacy of the royal touch; for he expressly declares that " His Majesty cured more persons of scrofula in one year than all the chirurgeons of London in an age."

The *local treatment* of scrofula merits great attention, although here it can be alluded to only in a very general manner, as each affection comprised under this denomination requires a mode of management in some respects peculiar to itself. The most important topical remedies are leeches, blisters, issues, pustulation with croton oil, tincture of iodine, embrocations, and sorbefacient unguents, especially such as have iodine for their bases, as the iodides of mercury, lead, potassium, iron, barium, cadmium, and zinc. Leeches are often of immense service; and, as to counterirritants, they can rarely ever be entirely dispensed with. Of the various sorbefacient applications none is entitled to a higher rank than the tincture of iodine, either pure, or as I generally prefer, considerably diluted with alcohol. It is used as in ordinary inflammation, and often exerts a powerful influence upon the progress of external scrofula, especially of the joints and cervical glands. Blisters, too, are a valuable means for relieving local congestion, modifying capillary action, and removing morbid deposit. If the part affected be a joint, rest, long and faithfully continued, will be necessary, if, indeed, not indispensable. If abscesses form, they must be opened, with the precaution, if possible, of excluding the air, unless they are situated very superficially, experience having shown that such ingress is highly prejudicial, not on account of anything noxious in the air itself, but because of its tendency to cause decomposition of the contents of the sac, and, consequently, violent reaction, or hectic irritation. The swelling is attacked in its most depending part, the knife being introduced in a valve-like manner, and the opening immediately closed with adhesive strips, supported by a compress and roller. The practice of permitting such accumulations to continue until they have seriously impaired structure, or caused intense suffering, cannot be too pointedly condemned.

When the enlarged glands obstinately resist treatment, they should be excised, provided they are sufficiently accessible, and there is no serious internal disease forbidding

interference. An operation is particularly indicated when the morbid growths press upon important neighboring structures, or when they are a source of great deformity, as when they are situated in the neck, under the chin, or about the angle of the jaw. The dissection is often tedious and bloody, especially when a large chain of glands has to be removed, and is then very liable to be followed by erysipelas and other bad consequences. When the glands have undergone caseous transformation they should always be removed with the view of preventing tubercular infection of other organs and tissues.

The scrofulous *ulcer* must be treated rudely at first, and gently afterwards. The undermined edges are cut away with the knife or scissors, and the surface is thoroughly touched with the dilute acid nitrate of mercury, the solid nitrate of silver, or sulphate of copper, the application being repeated every other day until there is an appearance of healthy granulations, when milder means, such as opiate cerate, or the dilute ointment of nitrate of mercury, take its place. If disintegrated glands are present, they are removed with the knife, or destroyed with the Vienna paste ; for so long as they remain, no substantial progress can be made towards a cure. Sinuses are traced out with the bistoury, unless they involve important structures, when stimulating injections, or the seton, must be used instead. Valuable aid will often accrue in these cases from the daily application of the dilute tincture of iodine to the surface immediately around the ulcer.

CHAPTER IX.

VENEREAL DISEASES.

THREE distinct affections are included under the term venereal. They all arise primarily from impure connection ; they are all contagious ; they all produce only their like ; and they may all coexist in the same person. Of these maladies, gonorrhœa is a catarrhal inflammation of the mucous membrane of the urethra or of the vagina ; chancroid is the local contagious venereal ulcer ; while syphilis is a specific disease, the initial lesion of which is chancre, or the constitutional contagious ulcer. The first of these affections will be considered in the chapter on the diseases of the male genital organs.

1. CHANCROID.

By the word chancroid is understood a disease which, in some of its features, resembles chancre, but differs from it in the fact that it is essentially a local contagious venereal ulcer ; whereas chancre is always the first manifestation of contamination of the system by the syphilitic virus. This distinction, which was for a long time held in doubt, is now generally, if not universally, admitted by the most distinguished and reliable syphilographers. It had, as will be seen, by a reference to the previous editions of this work, disturbed my own mind during nearly the whole of my professional life ; and it has only been within the last few years that, in consequence of the accumulating light of modern observation by men of the greatest opportunity, and the most reliable skill and judgment, in different parts of the world, my doubts have been finally removed. This perplexity was shared by many writers, and was caused, in some degree at least, by the fact that there are two kinds of chancres, a hard and a soft ; the latter, although very uncommon, being equally infecting with the former. Chancroid is supposed to have existed from the earliest ages of society, whereas chancre or true syphilis is said to be of comparatively modern origin, our first knowledge of it, as is alleged, being coeval with the discovery of this continent by Columbus in 1492. How erroneous this assertion is, it would be easy to show by an abundant array of facts gathered from the history of the various nations of the earth ; but as this is not the place to discuss the subject, it will be sufficient here to state that the first scientific and truly trustworthy attempt to separate the two diseases, or, in other words, to establish the doctrine of dualism, now so generally held, was first distinctly enunciated, in 1852, by Bassereau, of Paris. It is not surprising that this doctrine should have met with much opposition ; many of the best minds in the profession arrayed themselves against it ; but this opposition has gradually disappeared, and it may be boldly asserted that the number of unicists at the present day is as small as it is

uninfluential. It should not be forgotten, in this connection, that hardly one hundred years have elapsed since the doctrine of the identity of gonorrhœa and syphilis was successfully controverted.

What the precise nature of the poison of chancroid is is still an enigma. That its virulence resides mainly, if, indeed, not exclusively, in the pus globules of the secretion of the ulcer or sore whence it is derived, seems to be sufficiently established by clinical observations, as well by arguments derived from analogy. Rollet ascertained experimentally that, if the secretion of chancroid be freed from its globules by filtration, the remaining substance is innocuous. It is apparently owing to this fact that the virus, instead of entering the system and thus making an impression upon the constitution, is arrested in the lymphatic glands of the groin, where, sooner or later, it is capable of provoking suppuration and ulceration, the pus of which is, in its turn, highly inoculable. In fact, the sore thus produced is, in all essential particulars, a chancroid. Beyond this the matter does not travel; it is here that its action is arrested, and, however frequently it may affect the genital organs, it never infects the system, or occasion what are called secondary symptoms, such as are so constantly witnessed in syphilis. There may be, and indeed frequently is, irritative or inflammatory fever, but such excitement is entirely independent of the absorption of poisonous matter into the general system, as is invariably the case with the virus of syphilis; and the same is true of the pus that is furnished by the inflamed connective tissue around a suppurating gland, the product of the pus of chancroid. However abundant the fluid may be, it does not poison the constitution, so as to give rise to secondary phenomena, even supposing, as is undoubtedly the case, that some of the secretion occasionally enters the system; in other words, the secretion is devoid of contaminating power; its effects are purely local. Another peculiarity of this matter is that an individual who has once been the subject of it is at any time, if exposed to its contact again, liable to its influence; the virus of syphilis, on the contrary, rarely affects the same person twice, the impression made by it upon the system being, like that of smallpox, scarlatina, and kindred maladies, generally permanent or ineradicable.

It has been conjectured that the virulence of chancroidal matter is due to the presence of low animal or vegetable organisms, but if such parasites exist, they have never been satisfactorily demonstrated. The fact is, no mode of examination hitherto employed has succeeded in revealing its intimate nature. Its admixture with vaccine, gonorrhœal, or syphilitic matter does not necessarily impair its power; frozen and then thawed, it is still inoculable. Inclosed in a hermetically sealed tube, Ricord inserted it successfully at the end of seventeen days. Its potency, says Bumstead, is not destroyed by dilution with six to ten times its quantity of water. It is rendered innocuous, however, by exposure to a high temperature, and by admixture with alcohol, alkalies, and acids.

It has been supposed that the matter of chancroid may, under certain circumstances, arise spontaneously, and subsequently retain, for an indefinite period, its inoculable qualities. In support of this view, writers have cited the experiments of Pick, in which he inoculated simple, non-venereal matter of inflammatory origin, as that, for example, of acne, scabies, or pemphigus, upon syphilitic persons, and obtained well-formed pustules, the contents of which retained their nocuous properties through several generations. These results have since been verified by other observers; and Dr. Edward Wigglesworth, of Boston, has gone a step further by showing that the matter of acne and scabies, inoculated upon a perfectly healthy individual, will produce similar effects. Interesting as these experiments undoubtedly are, they fail, in my opinion, to prove that such fluids are capable of causing a true chancroidal disease; we might as well assume that simple, non-venereal pus could give rise to smallpox and other zymotic diseases. The only philosophical conclusion is that the secretion of chancroid is the invariable product of a specific inoculation.

It is still a mooted question whether chancroid can be transmitted from man to the lower animals. Hunter and Ricord performed numerous experiments upon dogs, asses, cats, rabbits, guinea-pigs, and pigeons, without propagating the disease in a solitary instance. On the other hand, Auzias Turenne, Diday, and other observers declare that they have succeeded in inducing the disease with matter of this kind in a number of the inferior animals. Fortunately, the solution of this question, one way or another, is of no practical moment.

The relative frequency of chancroid and chancre is worthy of brief notice, although, in a practical point of view, it is of little or no value. Of 10,000 cases of these affections observed by Puche at the Hôpital du Midi, 8045 were chancroids, and 1955 were chancres. Le Fort, on the other hand, finds that of 1789 cases, 951 belonged to the

former class, and 838 to the latter. Dr. Hardie, of the British army, ascertained that the proportion of chancroids to chancres in 303 cases was about two to one. It is highly probable that the relative frequency of the two affections is modified by local and consti- tional causes, as the peculiar character of the exposures, and the condition of the system at the time of the inoculation. Military surgeons have noticed that chancroids prevail in one garrison, and chancres in another; and it is not unlikely that similar occurrences take place among the residents of towns and cities.

The most common sites of chancroid are the genital organs, not that they possess any special aptitude over certain other parts, but because these structures from their peculiar situation are most frequently exposed to the contact of its peculiar secretion. All the mucous outlets of the body are more or less obnoxious to it; and, if matter of this kind be inserted underneath the epidermis in any region of the body, a specific pustule and ulcer will be certain to arise. Fournier has constructed a table of 445 cases of chancroid, in 347 of which the gland or prepuce was involved; various parts of the penis suffered in 70, the meatus in 11, and the interior of the urethra in 5. Debauge has published the statistics of 206 cases of this disease as occurring in women. In 78 of the cases the fourchette or navicular fossa was affected, the labia in 19, the nymphæ in 16, the urethra in 21, the lower part of the vagina in 24, the neck of the uterus in 1, the margin of the anus in 23, and the perineum and the groove between the nates each in 5.

A chancroidal ulcer may gradually wear itself out, or continue variously modified for an almost indefinite period, now stationary, now better or worse. As healthy granula- tions spring up the discharge sensibly lessens, the areola of inflammation, if there was any, disappears, and although the ulcer contracts under the influence of new tissue extending from the edges towards the centre, unless there has been uncommon destruction of tissue, such an ulcer seldom, if ever, leaves any trace to mark its former existence.

The rarity of chancroid on and within the uterus is worthy of special notice, as it is in singular contrast with the occurrence of chancre in those sites. A similar remark applies to the lips, tongue, and mouth, structures in which chancroid is exceedingly uncommon, while chancre is by no means infrequent, and may generally be readily in- duced by auto-inoculation, or by the insertion of matter into the affected person himself, or by hetero-inoculation, as when the secretion is transferred from one individual to another.

If the secretion of a chancroid be inserted just beneath the epidermis, a reddish blush will form around the puncture in twenty-four hours, which is converted into an inflamed areola on the second day, at the centre of which a vesicle forms, and is soon converted into a pustule. In the course of a few days the latter breaks, and discloses a circular ulcer with abrupt, sharply cut, and undermined edges, and a non-indurated, grayish, uneven floor, which secretes a tolerably abundant purulent fluid.

The chancroid, whether it results from inoculation or contagion, has no period of incu- bation properly so called, as is always the case with chancre. Indeed, well-marked symptoms often appear within the first twenty-four hours. Of 666 examples of the dis- ease observed by Le Fort, 510 attained their full development by the end of the first week. Early development is especially to be looked for when the virus during an impure inter- course is brought in immediate contact with an abraded or ulcerated surface. Then the fire is at once kindled into full activity. It is different when the offending matter has to work its way through a sound mucous crypt or an unbroken surface, inasmuch as this always retards its progress.

The chancroidal ulcer is generally more or less rounded in form, especially when it takes its rise in a mucous or sebaceous gland; when it begins in an abrasion, it is often very irregular, and not unfrequently exhibits the appearance of a fissure or groove. In the male it is most common at the free margin of the prepuce, or at, or just behind, the corona of the penis. Several chancroids often spring up simultaneously, as in fig. 75, from Cullerier, and others are liable to form during the progress from fresh inoculation, or the mere contact of their own secretions with the surrounding parts. In one case under my charge, in a woman, upwards of fifty years of age, I counted not fewer than forty sores of this kind, from the size of a mustard-seed to that of a three-cent piece, on the vulva and perineum. The surface of the chancroidal ulcer is generally superficial, flat, uneven, and coated with a grayish, whitish, or dirty, drab-colored deposit, evidently spoiled lymph. It has frequently a ragged, worm-eaten appearance. When the sore is seated on the head of the penis, its edges are steep and rather abrupt, as if it had been punched out, or sharply defined with a knife; but on the prepuce they are usually overhanging, sloping, or shelving, more or less ragged, and less closely identified than in chancre with the sur-

rounding structures.   The base of a chancroid is entirely free from induration, except in very rare cases in which irritating applications have been used, followed by an increase of morbid action and a deposit of plasma.   It is worthy of note that every ulcer of this kind is an inflammatory ulcer.

Fig. 75.

Multiple Chancroids.

A chancroidal ulcer generally manifests a disposition to spread, or to enlarge its area; and hence, especially in persons of a dilapidated constitution, occasionally runs into phagedenic action.   It furnishes an abundance of purulent fluid, which is highly contagious, and, therefore, readily inoculable, thus accounting, as already stated, for the multiplication of sores during the progress of the disease, one ulcer being superadded to another simply by the dissemination of the secretion over the contiguous surface. The sores are followed, in about one-third of the cases, by bubo, the disease being usually limited to one of the superficial glands of the groin, which, becoming gradually inflamed and swollen, suppurates, and eventually forms an ulcer, the matter of which, like that of the original sore, is of a highly inoculable character, and capable, in turn, of producing a chancroid if implanted into skin or mucous membrane.   Finally, a chancroid never contaminates the system, or gives rise to secondary and tertiary symptoms.

Well-marked febrile commotion sometimes attends this disease, but this, as a rule, is the case only when it is followed by more or less serious complications, when the inoculation has occurred during serious impairment of the general health, or when the attack is of an unusually virulent nature.   Ordinarily the constitution takes little or no cognizance of the local affection, any more than it does of a boil or common sore.   The pain is generally insignificant, except when the sores are very numerous or unusually large, or accompanied by severe swelling and other evidences of high inflammation.

Chancroid as now described is liable to be modified in its appearances, progress, and modes of termination by local and constitutional circumstances, among which the most important are the want of cleanliness and the degree of the concomitant inflammation, the habits of the individual, the state of the general health at the time of the inoculation, and the supervention of intercurrent diseases.   The influence which these several causes are capable of exerting is, in many cases, so great as to change the whole outward features of the existing ulcer; hence those numerous divisions and subdivisions of chancroid which have tended so much to embarrass the progress of our knowledge.   It is impossible for this disease to observe the same uniform course in every instance; alterations are inevitable, and must often occur despite the utmost caution both of the patient and his attendant.   In this respect, a chancroid holds the same relation as an ordinary ulcer, presenting one appearance to-day and another to-morrow; now highly inflamed, and now almost free from irritation; at one time in a healing condition, and at another ready to commit the most destructive ravages.   Out of these appearances, or varieties of appearances, have sprung the so-called inflammatory, diphtheritic, phagedenic, and sloughing chancroids, with several others which it is unnecessary here to mention.   Such occurrences constitute complications of disease rather than species and varieties, for they are liable to take place in all sores, whatever their character, whether simple or malignant, specific or common.   There is reason to believe that the specific poison may sometimes undergo such a radical change as to adapt it, in an especial manner, for the production of these differences in the appearances of the local affection.   Promiscuous intercourse with badly diseased women, particularly if they are foreigners, and receive the embraces of a considerable number of men in rapid succession, would seem to be a powerful predisposing cause of these accidents.   It was observed by the surgeons who accompanied the British army into Portugal that many of the soldiers who had connection with the native prostitutes suffered severely from phagedenic and gangrenous ulcers, while the residents of the country experienced very little trouble, and usually soon recovered from the effects of the disease.   The French soldiers, during Bonaparte's campaign in Egypt, suffered in the same manner.   Similar phenomena are frequently witnessed in the inmates of the houses of ill-fame in crowded cities.   Thus, in London, in Swan Alley, a narrow lane, celebrated as the residence of the humblest class of prostitutes, half starved, badly clothed, nearly constantly intoxicated, and having frequent intercourse every day with filthy lascars and other vagabonds, many of the cases of chancroid assumed the worst possible type, running rapidly into phagedenic action, and often causing frightful ravages and
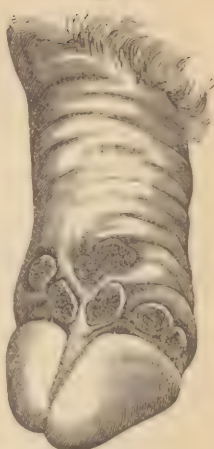
even loss of life. Examples of a like kind came under my observation in this city, in 1827, 8, and 9, in the Philadelphia Almshouse, and in the numerous brothels which then existed among the low blacks and whites south of Pine Street. What may be termed international chancroid, the result of sexual intercourse between civilized people and the low, degraded Indians of Mexico and South America, is, in every sense of the term, one of the very worst types of this disease, the poison acting with much greater virulence than under ordinary circumstances.

All chancroids are *inflammatory* affections, and it is, therefore, only when the concomitant action assumes a grave type that it can be regarded as unnatural. Under such circumstances, the characteristic symptoms consist of inordinate pain and swelling of the parts more directly involved in the disease, accompanied by an increase of discoloration, and an unhealthy aspect of the ulcer, which is the seat of a thin, ichorous discharge, more or less abundant, and generally a good deal irritating. Morbid erections are frequent, the prepuce is disposed to be œdematous, and the whole organ, especially the anterior extremity, appears to be enlarged. When the inflammatory action transcends certain limits, it may pass into gangrene or destructive ulceration, as occasionally happens in common ulcers of the leg, and from similar causes, especially from the excessive use of ardent spirits, loss of sleep, bad air, an impoverished diet, and improper courses of mercury. Or, the overaction may be brought on by a plethoric state of the system, and a neglect of the requisite depletion. I have seen gangrene and phagedenic ulceration of the genital organs of both sexes occur at a very early period, in consequence, apparently, merely of too active a course of treatment soon after the establishment of the disease, and such cases are sometimes characterized by extraordinary rapidity of progress, the suffering parts being, as it were, overwhelmed by the disease.

Phagedena is a rare complication of chancroid, especially in the better classes of subjects; it is analogous, in its worst forms, to hospital gangrene, and is most liable to show itself in persons whose constitution has been ruined by intemperance and other debilitating influences. As already stated, it sometimes occurs as an endemic, and is then probably induced by a foul state of the atmosphere, as when the disease breaks out in the crowded wards of public institutions; or by some peculiar modification of the chancroidal poison, greatly heightening its virulence, as when it takes place in soldiers after having cohabited with foreign prostitutes. The morbid action deports itself variously; in general it extends rather slowly, but continuously, gradually but effectually eroding the parts, and thus widening the breach as well as deepening it. Or, it may be that, as one portion of the chancroid heals, another spreads. Or, the action may be very acute, extending with extraordinary rapidity, and committing excessive ravages in an almost incredibly short

Fig. 76.

Acute Phagedena, burrowing beneath the Integuments of the Penis.

time. Or, lastly, the erosion may be conjoined with gangrene, the textures dying both molecularly and in mass. The phagedena may begin soon after the appearance of the chancroid, or it may manifest itself, as is most generally the case, at various periods of its progress. It may occur upon any portion of the genital organs, but is most common upon those parts of the mucous surfaces which are most plentifully supplied with follicles. In the male it is most liable to appear in the gutter behind the head of the penis, or at the point of reflection of the prepuce. The under surface of the penis, at the side of the frenum, is another favorite site, and when chancroid occurs here it is almost certain to destroy this fold of mucous membrane. The appearances of phagedenic chancroid are illustrated in fig. 76.

The phagedenic complication is sometimes followed by grave hemorrhage, the erosive action laying open, it may be, an artery of considerable size, as the dorsal artery of the penis, from which blood may issue in such quantities as to induce severe, if not fatal, exhaustion. The scarlet hue of the fluid and the saltatory character of the stream will at once indicate its source. In some cases it oozes from the ulcerated surface at many points, as water from a sponge.

Gangrene, as a consequence of chancroid, is more common on the prepuce than on the head of the penis, and, what is remarkable, the upper portion is more frequently affected than the lower or lateral. Occasionally both the head and foreskin are attacked simultaneously, or, if one suffer first, the other is soon attacked also, and in this manner the whole organ may gradually be involved, dropping off perhaps ultimately near the scrotum, or at its attachments to the pubic bones. The occurrence of gangrene is announced by a blackish spot, preceded and accompanied by a burning, smarting pain, and by an aggravation of all the other inflammatory symptoms. The system is extremely feverish, the

pulse is frequent and irritable, sleep and appetite are impaired, or, more commonly, entirely destroyed, and the patient is often slightly delirious. When the prepuce alone suffers, the whole of it may slough off, or, what is not unusual, it may be perforated at one or more points, the largest opening perhaps admitting the head of the penis, as in fig. 77. A common effect of gangrene, consequent upon chancroid, no matter where situated, is the destruction of the specific poison, thus effectually preventing inoculation of the lymphatic glands of the groin, provided that had not previously taken place.

The Sloughing Sore, the Prepuce being almost destroyed, and the Head going.

Chancroids sometimes assume a *serpiginous* form, the erosive process, as the term implies, creeping about in different directions, generally in circles or semicircles, one portion of the sore being perhaps cicatrized or partially healed while another is steadily advancing at the opposite point. The ulcer, although generally superficial, occasionally penetrates to a considerable depth, and, as its course is usually chronic, it often results in serious mutilation. Its surface, incrusted with grayish, greenish, or drab-colored lymph, is bathed with ichorous fluid, its edges being steep, ragged, and more or less everted. The serpiginous form of chancroid is most common in persons of a strumous constitution, especially if they are predisposed to phthisis, and herpetic affections. It is generally remarkably obstinate, and sometimes undermines almost the entire skin of the penis nearly as far as the pubes, from which it may extend into the groin, abdomen, perineum, or thigh, forming narrow, superficial tracks, which retain their specific character during the whole period of their existence, however protracted.

When the sore is incrusted with lymph, it constitutes what the French syphilographers have called the *diphtheritic* chancroid; such an occurrence is very common in all ill-conditioned specific ulcers upon the genital organs, and is always denotive of an unusually irritable and inflamed condition of the part, the action of which altogether transcends the healthy limits, nature being incapable of converting the deposit into granulations, and so throwing it off in the form of a slough, or as an effete substance.

Diagnosis.—The diagnosis of chancroid is often difficult and sometimes impracticable, particularly in its earlier stages, before the disease has assumed its more distinctive features. The affections with which it is most liable to be confounded are chancre, herpes, eczema, balanitis, and simple excoriations, fissures, or abrasions, the result of friction and other accidents.

The diagnosis between chancroid and chancre will be fully discussed in the section devoted to the consideration of the latter. Here it will suffice to state, in general terms, that chancroid is characterized, in contradistinction to chancre, by its rapid development, its abundant secretion, the absence of induration, and its tendency to multiplicity, one sore being frequently followed by another simply from the inoculable nature of the discharges.

Herpes is an eruption on the prepuce and head of the penis of little vesicles, hardly as large as the head of a pin, occurring in groups, closely set together, of a whitish color, and resting upon a florid base, with which they form a striking contrast. They are most frequent on the inner surface of the prepuce, in persons of red hair and tender skin, and often appear in successive crops, none of which, however, last longer than six or eight days. Characterized by a sense of itching and a slight serous discharge, they manifest little disposition to extend, and usually promptly yield to very simple treatment. The resulting ulcer is always free from induration.

Chancroids rarely put on the appearance of herpes. The only approach to it is where the ulcers are seated in the mucous follicles, but even then their circular form and excavated character will always serve to distinguish them from common sores.

Eczema is also an eruptive disease, but the little vesicles are more minute and diffused than in herpes, and there is also usually a greater amount of local irritation, the parts being swollen, hot, red, and itchy. When the vesicles burst, a thin, watery fluid escapes, succeeded by the development of small, delicate scales. The affection is apt to become chronic, and then little crevices generally form, increasing the irritation, and furnishing an acrid, sero-purulent, sanious, or ichorous discharge. Eczema is most common on the prepuce, and is often particularly conspicuous at its free border. A careful examination of the affected structures, the history of the case, and the existence of eczema in other parts of the body, will always lead to a correct distinction between this disease and chancroid.

An inexperienced practitioner might possibly mistake an incipient balanitis for a

chancroid, but no one who has ever seen the two diseases could commit such an error. In balanitis the inflammation is generally widely diffused, often, indeed, over the whole surface of the prepuce and head of the penis, and the discharge is not only profuse, but of a thick, muco-purulent nature from the very commencement. There is no circumscribed ulceration as in chancroid, and, indeed, little or no tendency whatever to destruction of tissue. These characters will always serve to prevent the disease from being confounded with chancroid, which invariably presents itself as a distinct and well-defined ulcer.

Simple ulcers, abrasions, or excoriations are liable to appear upon the prepuce and head of the penis, and may, unless great caution is exercised, be mistaken for chancroids. They may proceed from a great variety of causes, as want of cleanliness, friction of the pantaloons, injury received during copulation, and intercourse with filthy females, especially such as are habitually the subjects of profuse and acrid discharges. However induced, such ulcers are always very superficial, and display no disposition to extend in depth, although they may spread considerably in diameter. The secretions which attend them are of an ichorous character, and they are usually surrounded by an inflammatory border, which is seldom the case in chancroid. The most important diagnostic feature, however, by far, is that such ulcers always very promptly disappear under the most simple remedies, attention to cleanliness, with cooling lotions and a mild aperient, generally sufficing to effect a cure in a few days.

Epithelioma is sometimes, but rarely, mistaken for chancroid. The absence of ulceration and discharge in the earlier stages of the disease, and the tuberculated, warty, or cauliflower-like appearance of the sore after the occurrence of ulceration, together with the peculiar quality and quantity of the secretion, the fluid being always of a thin ichorous or sero-purulent character and much more copious and fetid than in chancroid, are the most trustworthy diagnostic phenomena. The history of the case usually affords additional light. Most of the epithelial growths in fact, occurring upon the prepuce and head of the penis, reveal their own secrets.

The site, size, shape, appearance, and course of chancroid, considered separately, afford no reliable diagnostic evidence; but, collectively, are of great importance as means of discrimination. Thus, mere site and size are of no consequence, because a chancroid may, like a common sore, occur on any portion of the penis and be very diminutive, as when, for instance, it occupies a mucous follicle; but if, in addition to this, the ulcer is found to be excavated, to have a foul, diphtheritic bottom, to pursue a chronic course, and to resist the ordinary means of cure, it is quite impossible to mistake its character; we conclude that it is chancroidal, and nothing else.

The history of the case often affords valuable information. If the patient is a married man, or if he has any other motive for concealment, he will be likely to deny that he has had impure connection, and even insist upon it that the sore on the penis is non-specific. Under such circumstances, it is not necessary to try to convict him of falsehood; the surgeon examines the parts, and if he finds any suspicious-looking ulcers, he will very naturally conclude that they are venereal, and this opinion will be strengthened by the very denials of the patient, especially if he is noted for his gallantries. Young unmarried men usually treat their attendants with entire candor, generally specifying with great particularity the time of the impure connection, and evincing no little anxiety to afford them all the light they can, with a view of settling the diagnosis. We must not, therefore, on the one hand, believe that a man has not been exposed to infection simply because he says so; or, on the other, take it for granted that every sore that may be found upon the penis is of a specific nature.

Finally, in all cases of doubt the groins should be examined with reference to the existence or non-existence of bubo. In the ordinary non-specific affections, above described, glandular enlargement is extremely rare, and it usually appears early in the attack, the bubo being small and always comparatively transient. In chancroid swelling of the groin occurs only once in every third or fourth case, and is invariably attended with more or less pain, aggravated by exercise and pressure, and tending to suppuration. In chancre, the swelling is indolent, non-inflammatory, and persistent; it rarely appears before the twelfth or fifteenth day from the impure contact, and very seldom passes into suppuration or ulceration.

When the above means of diagnosis fail, as they seldom will, if proper care be used, the only other resource is inoculation, a small quantity of the suspected matter being inserted, upon the point of a lancet, into the skin on the inside of the thigh. If the oper-

ation is gradually followed by a vesicle, and this, in turn, by a pustule, with a well-marked areola, there can be no doubt whatever respecting the true nature of the disease. Inoculation, if properly executed, cannot deceive, and is, therefore, after all, the only true and reliable test, although there are few surgeons of experience who will not, as a general rule, be able to determine the diagnosis without its aid.

The prognosis of chancroid is always favorable in the milder forms of the disease occurring in persons of sound constitution. In neglected cases, however, or cases complicated with high inflammation, the disease often assumes a very serious character, causing great suffering, local and constitutional, and, perhaps, more or less extensive loss of substance. In former times when chancroid was a much more severe affection than it is at the present day, it was not uncommon, especially in persons of depraved constitution, rendered so by intemperance, debility, exposure, or the use of mercury, to witness gangrene of the affected organs, large portions of which occasionally sloughed off. Gangrene of the prepuce is a possible occurrence in phimosis attended with great œdema. In chancroid of the urethra stricture is almost inevitable under any circumstances. In chronic or neglected cases the disease may continue for months, or even years, causing more or less suffering and more or less mutilation.

Prophylaxis.—If the old adage, " an ounce of prevention is worth a pound of cure," is any where applicable to diseases, it is emphatically so in the venereal affections. The susceptibility to the disease varies, as is well known, very greatly in different persons, some being remarkably prone to suffer from the slightest contact of the specific matter, while others, less delicately organized, escape with impunity. When a man has exposed himself to suspicious intercourse, the penis should immediately be washed with soap and water, special care being taken to cleanse the margin of the prepuce, the groove at the neck of the penis, and the parts around the frenum; for it is at these points, more particularly, that the virulent matter is most liable to effect a lodgment. Women should use a large syringe, charged with a strong solution of alum, common salt, chlorinated sodium, or permanganate of potassium, with which the vagina should be thoroughly cleansed, the fluid being thrown up with considerable force against the uterus with a Davidson's syringe. The nymphæ, labia, and perineum must be washed with a sponge. A very excellent lotion for preventive purposes, much used by the prostitutes of Bordeaux, is composed of half an ounce of alum, and of fifteen grains each of sulphate of copper and sulphate of protoxide of iron, dissolved in a quart of distilled water, with the addition of one drachm and a half of compound aromatic alcohol.

In some of the larger cities of Europe, especially on the continent, the occupants of houses of prostitution are regularly inspected once, if not twice, a week, with a view to the prevention of the spread of these diseases, and it is to be regretted that the practice has not been introduced in this country, considering the immense benefit which, if it were properly carried out, it would confer upon the public, by the insurance of greater cleanliness, and the consequent diminution of the frequency of the miseries entailed by these maladies. It is a fact of not a little diagnostic value that, while a chancroid is, as a rule, always easy of detection with the speculum, a chancre, owing to its small size and illdeveloped character, is readily overlooked.

Treatment.—The treatment of chancroid in its early stages, or before the lapse of ten days, if there are no decided contraindications, growing out of the existence of severe inflammation, must be conducted with the threefold object of shortening the duration of the disease, destroying the contagious principle of the secretion, and preventing the formation of a bubo. As excision of the sore is rarely of any avail, an attempt to accomplish these objects should be made by means of escharotics. The one most generally selected is nitrate of silver, cut to a very delicate point, and inserted into the ulcer, or broken vesicle, where it is held until the infected tissues are brought thoroughly under its influence. The objection to this substance is its insufficiency; for, whether it act simply as a neutralizer of the poison or as an escharotic, it is equally certain that it is generally unreliable, and it should, therefore, never be used in a disease of such a serious nature. The article to which I have long given the preference, on account of its superior efficacy, is the officinal solution of the acid nitrate of mercury, applied either pure or variously diluted, according to the exigencies of each particular case. A good average strength is one part of the acid to double the quantity of water, applied with a piece of soft wood, the end of which is smooth and well rounded off. Such a contrivance is much better than a probe wrapped with lint and cotton, as the fluid can thus be brought in contact with the infected surface in a more concentrated and efficient manner. In order to prevent the solution from diffusing itself too widely, the part should previously be well

wiped, and immediately after bathed in pure water, or some weak alkaline lotion. The most suitable dressing is an emollient poultice. One free application of the acid generally suffices.

When acid nitrate of mercury is not at hand, almost any of the acids may be employed, especially the carbolic, nitric, or hydrochloric. Some surgeons use caustic potassa, while others give a preference to the Vienna paste. Ricord recommends a powerful caustic, composed of sulphuric acid and powdered charcoal, united in the proper proportions to form a semisolid mass. Of this carbo-sulphuric paste, as it is called, a thin layer is applied to the chancroid and the parts immediately adjacent, upon which it soon dries, forming a black, adherent crust, which, on dropping off, as it usually does in eight or ten days, leaves a healthy, granulating sore, rapidly followed by cicatrization. The objections to the carbo-sulphuric paste are the extreme pain which it produces, and its tendency to spread too widely over the sound tissues. Of late years I have found that pure carbolic acid is the least painful and one of the most valuable of the escharotics.

Abortive measures are justifiable only in the very earliest stages of the disease, before the supervention of marked inflammatory action. When this stage has been passed such treatment cannot fail to do harm by increasing the local irritation. Mild measures alone are proper in such a condition. From neglect of this precaution, which cannot be enforced with too much emphasis, many a sore on the genital organs that would, if properly managed, disappear in a few days, is often protracted for weeks, if not months, to the great detriment both of the part and system. Young and inexperienced practitioners are very prone to fall into this error; they think they cannot do too much, and the consequence is that they fret and worry the sore until it places itself, so to speak, in a state of open rebellion, resisting all measures, local and constitutional, that may be adopted under the delusive hope of effecting its cure. Rest and attention to diet are of inestimable value in every case. Strict confinement to the house is not always necessary by any means, but any thing like excitement, physical or mental, should be scrupulously guarded against; the bowels should be moved from time to time with cooling laxatives, and no animal food, unless absolutely called for by the exhausted condition of the patient, should be permitted. This kind of indulgence never fails to retard the cure, and often leads to serious complications, and yet, strange as it may seem, it rarely engages the surgeon's attention. If the secretions are disordered, as evinced by the coated tongue, the depraved appetite, bad taste in the mouth, or distressing headache, an active mercurial cathartic may be administered; but for no other reason should mercury ever be employed in the treatment of an affection which, as is now well known, never contaminates the constitution in the sense that syphilis does. Febrile excitement is kept in abeyance with the neutral mixture, or antimonial and saline preparations, with the addition to each dose of a few drops of tincture of aconite. Anodynes are given to relieve pain, induce sleep, and prevent reaction; in a word, the whole treatment is conducted upon strictly antiphlogistic and soothing principles.

Cleanliness is of the utmost importance in every case of the disease, and is best secured by frequent immersion of the penis in warm water, containing a little common salt, acetate of lead, or chlorinated sodium. If the chancroid is concealed by a tight and irritated prepuce, the syringe is freely used, as it will be impossible to effect retraction to an extent sufficient for ordinary ablution. In the intervals of these local baths, which, while they favor cleanliness and comfort, contribute materially to the reduction of the inflammation, the ulcer should be kept constantly covered with lint, wet with a weak solution of tannic acid and opium in compound spirit of lavender, yellow wash, sulphate of copper, or acetate of lead. Tannic acid and opium are most excellent remedies, exerting at once an astringent and soothing influence, greatly promotive of healthy action. They form the principal ingredients of the aromatic wine, so much used in the French hospitals, and their efficacy has been well attested both in public and private practice everywhere. The yellow wash is also a very valuable agent, but to obtain all the good which it is capable of yielding, it should be employed very weak, as one-eighth of a grain of the mercury to the ounce of lime-water, the strength being increased if necessary on account of the slow progress of the case. The officinal preparation is much too strong and irritating. I have frequently derived great benefit from the ointment of nitrate of mercury, diluted with eight, ten, or twelve parts of simple cerate, and applied either alone or in union with tannic acid and opium. In fact, there is no remedy which has done better or more efficient service in my hands than this in the treatment of simple chancroid. Powdered iodoform, sprinkled on the sore, is highly praised by many practitioners as an excitant to healthy granulations; but its odor is so penetrating and disagreeable as to make it objectionable in

private practice. This disagreeable feature may be overcome by employing the remedy in the form of an ointment composed of one drachm of iodoform, two drachms of balsam of Peru, six drops of oil of peppermint, and five drachms of cosmoline. Employed in this way it constitutes an excellent application, especially when the sore is seated upon the integument.

There is one important rule which applies here with as much force as in the case of common ulcers, and that is to vary the dressings whenever they are found to become a source of irritation, or cease to be beneficial, making them now weaker, now stronger, adding new ingredients, omitting old ones, or changing the remedy altogether. Much of the success, in every case, will depend upon the care with which this rule of practice is carried out.

When the parts begin to granulate, the simplest dressings generally suffice, such as opiate cerate, or ointment of red oxide of mercury, diluted with eight, ten, or twelve times its bulk of cosmoline, or merely a bit of dry lint carefully interposed between the contiguous surfaces. The latter application often promotes cicatrization with remarkable rapidity.

When the head of the penis is swollen and painful, it must be kept constantly buried in an emollient poultice, made of powdered elm bark or ground linseed, and frequently changed. Or, instead of this, warm water-dressing may be used, its efficacy being increased by the addition of laudanum and acetate of lead. The best vehicle for such dressing is cotton wool, in which the organ, properly elevated, and maintained at rest, should be completely buried.

Constitutional treatment is too important to be overlooked, however simple the sore. Perfect quietude of mind and body is indispensable. The effects of any disturbance of this kind always manifest themselves promptly in the aspect of the sore and the character of the secretions. The diet must be plain and simple, animal food and stimulants being carefully avoided; the bowels are kept open by cooling purgatives; and, if need be, free use must be made of saline and antimonial preparations. Venesection will rarely be required, and then only in very plethoric subjects. If the local trouble is considerable, leeches may be applied to the groins or to the inner surface of the thighs, the bites being well covered, when the flow of blood has ceased, with collodion, in order to prevent their inoculation from the accidental contact of chancroidal matter. Leeches should never be applied to the penis itself, much less to the parts immediately affected, as their secretions could hardly fail to come in contact with the little wounds, and so propagate the disease.

When chancroid is accompanied by severe *inflammation*, as denoted by the swollen, discolored, and painful condition of the parts, and the feverish state of the system, antiphlogistic means should at once be vigorously employed. Active purgation, light diet, the neutral mixture, and the use of antimonials, with absolute rest in the recumbent posture, cooling, anodyne, and mildly astringent lotions to the ulcer, and an emollient poultice or warm water-dressing for the head of the penis, constitute the chief remedies in such an emergency, and must be carried to an extent compatible with the powers of the system. Pain and morbid erections are relieved with opiates and bromide of potassium, administered in full doses. By these means the disease is soon brought under subjection, when it is to be managed in the same gentle manner as the milder forms of chancroid already described.

Chancroid of the frenum is almost invariably followed by perforation of that fold, and, in such a case, the cure is always greatly expedited by its prompt division, the raw surface being immediately cauterized with carbolic acid.

When the ulcer assumes a *phagedenic* character, with a tendency to spread more or less rapidly both in depth and diameter, the principal addition to the treatment, required in chancroid complicated with undue inflammation, consists in the increased amount of opium employed to soothe the part and system, which are generally excessively irritable in this variety of morbid action, and can only be successfully quieted by the most liberal use of this article. If the skin be hot and arid, the pulse excited, and the face flushed, the opium should be combined with antimony, or some cooling diaphoretic, so as to produce a decided determination to the surface. The diet and bowels must receive due attention; all stimulants must be avoided; and the mind and body must be maintained in the most tranquil condition.

The local applications should all be of the blandest kind, consisting of warm water-dressing or emollient poultices, and of lint steeped in mucilage of gum arabic, or an infusion of elm bark, with the addition, to each ounce of fluid, of two or three drops of

nitric acid and one drachm of the vinous tincture of opium. If the disintegrating action is very rapid, the ulcer should be covered with iodoform, or be freely mopped with a weak solution of acid nitrate of mercury, or, touched with solid nitrate of silver, its surface being kept constantly covered in the interval with the medicated lotion just mentioned. In some cases nothing arrests the erosive tendency so speedily as a weak solution of sulphate of copper, in the proportion of about one grain to the ounce of water, with the addition of four to six times that quantity each of tannic acid and opium. When the action is obstinate, immersion of the parts in hot water is very efficient in arresting its progress and in relieving pain.

The phagedenic form of chancroid, however, does not always occur in the strong and robust; the system may be, and often is, in an adynamic condition, requiring tonics and stimulants instead of depressants. The constitution, degraded perhaps by long suffering, by starvation, and by all kinds of intemperance, must be brought up with quinine and iron, porter, ale, or milk punch, a generous diet, and change of air, particularly if the patient is the inmate of a crowded and ill-ventilated hospital. The dissipated and enervated residents of large cities are particularly prone to suffer from phagedena during the progress of chancroid, and it is, therefore, impossible to be too cautious in regard to the employment of depletory measures. What is needed in such a state of the system is perfect tranquillity of mind and body, as secured by the liberal exhibition of anodynes, and a better condition of the blood, to enable the part to institute a more salutary action.

If *gangrene* set in, the treatment must vary according to the concomitant state of the system, independently of any consideration growing out of the presence of the specific virus. The question should simply be, is the action of the system too high or too low? If the former, antiphlogistics will be indicated, and should be promptly employed, although not without a certain degree of reserve, lest the powers of the constitution should suffer from the effect, and thus encourage the spread of the disease. Depletory measures, if used at all, must be used warily. The excitement may only be apparent, not real; and may, consequently, shortly subside, either spontaneously, or under very simple remedies. Most likely the action is typhoid from the beginning, or, if not, it soon will be; hence, instead of a depletory, a corroborative course will be necessary, similar to that in ordinary gangrene in other parts of the body, the chief reliance, so far as constitutional means are concerned, being upon quinine, iron, ammonia, brandy, camphor, and opium, with milk and rich animal broths. The use of potassio-tartrate of iron, in doses of ten to twenty grains, repeated four or five times in the twenty-four hours, has been greatly lauded in this form of the disease; but, judging from the results of my own experience, it possesses no advantages whatever over the sulphate and tincture of the chloride, so much employed in all anemic states of the system.

To arrest the gangrenous action, and promote the separation of the eschars, the affected structures should be freely painted with dilute tincture of iodine, and wrapped up in an emollient poultice, medicated with laudanum and acetate of lead, Goulard's extract, or what is superior to either, a saturated solution of potassio-tartrate of iron, while the dying tissues are well mopped with the acid nitrate of mercury, or brought under the full influence of carbolic acid. If any constriction exist, as that produced by a tightened and retracted prepuce, it must promptly be relieved with the knife. The detachment of the sloughs may be promoted artificially, or, if not too large, be intrusted entirely to nature's efforts; at all events, all harsh interference must be carefully avoided. Fetor is allayed with chlorinated sodium, permanganate of potassium, or other means.

The sloughs having separated, the next object is to favor the development of healthy granulations; for which the most available remedies will be found to be the nitric acid lotion, with tincture of opium, the ointment of the balsam of Peru, the aromatic wine, or the dilute ointment of acid nitrate of mercury, with warm water-dressing or an emollient cataplasm, as a general covering to the affected structures. A lotion composed of five to ten grains of potassio-tartrate of iron to the ounce of water is often very beneficial in improving the condition of the sore.

The *serpiginous* chancroid is generally an obstinate and troublesome sore, for the cure of which one of the most efficient local remedies is a saturated solution of potassio-tartrate of iron, applied upon lint. In very rebellious cases it is sometimes necessary to use strong lotions of nitric, carbolic, or hydrochloric acid, or even to sear the surface of the ulcer with the actual cautery, with a view of changing its condition. The undermined and partially devitalized edges must be removed with the scissors. Constitutional treatment is indispensable. Chalybeate tonics, cod-liver oil, a generous diet, exercise in the open air, or a residence at the seaside, will greatly assist recovery.

In the *diphtheritic* chancroid the most efficient remedy for reducing the inflammation is the warm water-dressing, or an emollient cataplasm, medicated with opium and sugar of lead, the sore being touched once a day with solid nitrate of silver, or brushed over with a weak solution of acid nitrate of mercury. Under this management, aided by suitable constitutional means, the sore soon assumes a more healthy action, followed by the development of florid granulations, and a gradual tendency to cicatrization and a final cure.

The *indolent* chancroid, or chancroid attended with deficient action, generally depends upon some defect of the system, by correcting which the ulcer will speedily assume a healthy appearance, throwing out florid granulations, furnishing thick, laudable pus, and cicatrizing along its margins. Or it may be that the obstacle is of a strictly local nature, occasioned by want of cleanliness, by an undermined condition of the sore, or, by the presence of a thick, semiorganized, and firmly adherent layer of lymph. Whatever the cause may be, it should, if possible, be promptly rectified; the constitution, if at fault, is suitably improved, and every effort is made to promote the granulating process. Particular attention is given to cleanliness, the thickened and shelving edges are trimmed off with the scissors, and the incrusted surface, freely cauterized with nitrate of silver, nitric acid, or acid nitrate of mercury, is kept constantly covered with blue ointment or some stimulating lotion. The best internal remedy generally is the tincture of chloride of iron in doses of twenty drops four times a day, in union with quinine. The potassio-tartrate of iron is also a valuable agent, and may be given in doses of ten to fifteen grains every eight hours, dissolved in water and syrup of orange peel.

Any *hemorrhage* that may arise during the progress of chancroid must promptly be arrested; the patient may already be much exhausted by previous suffering, and a slight drainage of this kind might, therefore, prove exceedingly prejudicial. When the blood issues from an open orifice, the vessel should at once be secured by ligature, acupressure, or compressing forceps, a sufficiency of tissue being included in their bite to insure safe maintenance. If, on the contrary, it proceeds from numerous points, the ordinary styptics, as alum, or, what is better, Monsel's salt, with a full dose of opium and aconite to control the heart's action, will generally suffice for its speedy arrest.

The morbid *erections* which so often accompany chancroid, and which generally so much impede the reparative process, must be treated in the same manner as in gonorrhœa; by the liberal use of anodynes by the skin, mouth, or rectum, and by soothing topical applications, either warm or cold, as may be most grateful to the part and system. If hemorrhage be present, they must be controlled at all hazards, on account of their tendency to tear open the bleeding vessels.

Phimosis, complicating chancroid, must not be interfered with, unless it act constrictingly, threatening destruction of the prepuce and of the glans by mortification. In this event, the parts must be freely divided upon the grooved director, the edges of the incision being immediately cauterized with carbolic acid or acid nitrate of mercury, and coated with a layer of collodion to prevent inoculation. In ordinary cases, the tightened foreskin is permitted to retain its place, cleanliness and medication of the ulcer being effected, as already stated, by means of the syringe.

Paraphimosis is occasionally present, perhaps to a perplexing and even dangerous extent. The constriction produced by it may be such as to cause excessive œdema of the prepuce, and great engorgement, if not severe swelling of the head of the penis, inducing a condition which, if not speedily relieved, may eventuate in extensive gangrene. These effects may occur whether the chancre be situated on the head or on the retracted prepuce, and, for the reason just mentioned, always demand prompt attention. An attempt should be made to restore the parts by manual effort, aided by anæsthesia, to give the surgeon more perfect command over his movements. This failing, the only alternative is to divide the stricture, and to keep the wound well coated with collodion, to prevent further inoculation.

Chancroids in women.—The structures which are most liable to suffer from chancroids in woman are the vulva, labia, nymphæ, vagina, urethra, and the vicinity of the clitoris. The inferior third of the vagina is more frequently affected than the middle or upper third, and the uterus suffers least of all. A very common site of chancroids is the fourchette, its dependent position favoring the contact of the contagious secretions, no matter what parts of the genital organs may be involved in the specific disease. For a similar reason, the perineum, the anus, and even the buttocks are occasionally covered with chancroids. In the case of an elderly woman, previously alluded to, I counted forty chancroids upon the perineum.

Chancroids upon the female genitals affect almost every variety of number, size, and shape. Generally they are multiple, from autoinoculation of the secretions; of small dimensions, and of an irregularly rounded or ovoidal shape; sometimes they occur in the form of fissures, and at other times they coalesce or run into each other, forming thus ulcers of large size. However this may be, they seldom, except in women of dilapidated constitution, reach to any great depth, but are usually superficial, although they always furnish an abundance of thick, purulent, and highly inoculable matter. Great pain and swelling are often present, especially when the chancroids occupy the labia, the lower part of the vagina, or the anus and perineum. Chancroids of the urethra often cause excessive suffering and extensive destruction of tissue. Occasionally the vesico-vaginal septum gives way, and stricture of the anus, and even of the rectum is by no means an uncommon occurrence. Chancroids in the female genitals are liable to be followed by phagedena, gangrene, and other serious effects, precisely as in the male; buboes, are, however, less frequent. Ulcers of the uterus are generally difficult to cure, and are more apt to take on phagedenic action, often destroying large portions of the neck of the organ, and even extending some distance up the canal.

The diagnosis can only be determined by the history of the case and by careful ocular inspection. The rapid development of the sores, their multiple character, and the profuse, inoculable secretion, and the existence of more or less pain, form important elements in the discrimination of the disease. In case of doubt, inoculation may be practised.

In the treatment of chancroids of the female genitals, the same general rules are applicable as in the corresponding affections in men. Absolute rest in the recumbent posture, active purgation, saline and antimonial preparations, opiates, diaphoretics, the warm bath, and light diet, constitute the most appropriate remedies in ordinary cases. The most important topical means are frequent injections of hot water, or of hot water medicated with alum, chlorinated sodium, or carbolic acid; the application, especially if there be overaction threatening the occurrence of phagedena or gangrene, of weak solutions of acid nitrate of mercury; and, above all, isolation of the affected surfaces with plugs of lint or cotton, medicated with aromatic wine, lotions of tannic acid and opium, yellow wash, or some slightly stimulating ointment. Pain is allayed, and rest secured with anodynes in full doses, repeated as often as may be necessary. Tonics and other supporting measures are of course necessary in exhausted states of the system.

CHANCROIDAL BUBO.

Bubo essentially consists of an enlargement of the lymphatic glands of the groin, and is the result of the transference of the virus of the original sore to the latter situation. Hence it is capable of furnishing a secretion similar to that by which it was itself produced. An open chancroidal bubo is, in fact, nothing more or less than a chancroidal ulcer, resembling in every essential particular a chancroidal ulcer of the genital organs. Like the latter, it is wholly of a local nature, or, in other words, incapable of contaminating the system. The chancroidal bubo is present only in about one-third of the cases of chancroidal disease, whereas the true syphilitic bubo, or glandular enlargement, is a universal sequence of inoculation with the syphilitic virus; the latter never tends to suppuration, is strictly indolent, and is characterized by a remarkable degree of induration, seldom noticeable, as a prominent feature, before the end of the tenth to the fifteenth day from the time of the impure contact. Moreover, the syphilitic bubo is always followed by constitutional disease, or, more correctly speaking, is an evidence that the system has already been invaded.

The chancroidal bubo is usually limited to one or at most two glands, although others may become involved during the progress of the disease, not by direct inoculation but by an extension of the inflammation which always accompanies the inoculation. The relative proportion of bubo to chancroid has not been definitely settled; but it will be sufficiently near the truth if it be put down at one case in every three, three and a half, or four. An active, open state of the primary ulcer, and the smallest conceiveable amount of inflammation in the structures immediately around are, other things being equal, the conditions most favorable to the development of the disease. Large or numerous sores attended with an abundant discharge of pus also materially contribute to the occurrence. On the other hand, the absorption of the specific virus and its transmission by the lymphatic vessels to the groin are accomplished with great difficulty when the parts are overpowered by disease. The occurrence of phagedena or gangrene early during the progress of the primary ulcer is sure to act as a preventive.

The bubo generally occurs on the same side as the primary sore. Thus, if the ulcer exist on the right side of the penis, the right groin will be the one to suffer, and conversely. Occasionally an exception to this rule is met with, depending, probably, upon an interlacement of the lymphatic vessels, those of the right side passing over to the left, and the reverse. A bad form of bubo sometimes occurs at the root of the penis, or upon the pubes, caused by the presence of an infected gland. Now and then a bubo is developed in each groin, especially when the chancroid is situated upon some part of the middle line, as the frenum or the upper surface of the penis.

The chancroidal bubo is much more frequent in men than in women, owing to the differences in the arrangement of the lymphatic vessels, those of the former passing in a much more direct manner than those of the latter from the seat of the disease. In chancroid of the uterus and the upper part of the vagina bubo is uncommon, and the same law obtains in regard to chancroid of the urethra in the male.

An opinion was at one time extensively prevalent that a bubo may form in the groin without the intervention or antecedence of chancroid, from the direct absorption of the specific poison from a mucous or cutaneous surface. It was and still is maintained by some that such an effect is possible, because, as is alleged, virulent bubo occasionally occurs without any evidence whatever of having been preceded by primary ulcers. It is assumed that the matter in which the poison is entangled, or held, as it were, in solution, may be absorbed by the mucous or even the cutaneous surface of the penis in the same manner as morphia, atropia, and other articles of the materia medica, and that, being subsequently conveyed by the lymphatic vessels to the groin, it is capable of infecting its glands in such a way as to form a true chancroidal bubo. Hence, the disease has been called the primary non-consecutive bubo, or, to use a French phrase, bubon d'emblée. The existence of this variety of bubo was admitted by several of the older writers on venereal diseases, especially by Astruc and Swediaur; Hunter also believed in it, and it was at one time dwelt upon at much length by Ricord and his disciples. Many of the most experienced practitioners, however, in all parts of the world, positively assert that they have never met with it, and, as for myself, I am sure that no instance of the kind has ever fallen under my observation.

Varieties.—Bubo, like chancroid, is susceptible of a great variety of forms. Thus, it may, after having made a certain amount of progress, remain stationary, perhaps even for several months, manifesting no decided disposition either to advance or to recede. In another class of cases the enlarged glands, taking on inordinate inflammatory action, pass into *suppuration*, the matter usually collecting in a solitary abscess, of an ovoidal shape, from the volume of an almond up to that of a goose's egg. When the disease assumes this form, it generally runs its course with considerable rapidity, being characterized by severe constitutional disturbance, such as rigors, fever, and headache, and by intense local suffering, the pain being of an aching, throbbing character, the swelling great, the heat excessive, and the discoloration of a dusky livid red. If the matter, which is generally of a thick, yellowish appearance, intermingled with blood and cellular sloughs, is not promptly evacuated, it is apt to burrow among the neighboring tissues, causing extensive sinuses, which it is often extremely difficult to heal, and which occasionally lay open most important structures. In neglected cases, such an abscess may, on the one hand, pass high up over the abdomen, and, on the other, low down upon the front of the thigh. Dr. Lente has reported a case of virulent bubo in which the matter perforated the abdomen, and induced fatal peritonitis. In a case mentioned to me by Dr. J. M. Barton, upwards of a quart of pus was discharged through the rectum, the patient, notwithstanding the most extensive suppuration of the groin, thigh, and abdomen, making eventually a good recovery. Whenever the quantity of matter is unusually large, it may be assumed that it is mainly furnished by the connective tissue in which the affected glands are wrapt up, and not by these bodies themselves.

When the contents of the abscess have been discharged, whether spontaneously or otherwise, the disease assumes the name of an open, *ulcerating* bubo, a state in which it may remain, with very little change, for an almost indefinite period. The discharge from such a sore, which is always situated above Poupart's ligament, or partly above and partly below, and which inclines from above downwards and inwards, may partake more or less of the character of laudable pus, or it may, as is most common, be thin, ichorous, and irritating, the quantity varying from several drachms to upwards of an ounce in the twenty-four hours. It retains its specific properties until cicitrization is completed. The edges of the sore exhibit very much the same appearances as those of a common ulcer; thus, they may be very steep, and ragged; everted, inverted, or undermined; thick or

thin; pale, reddish, dusky, or purple. The bottom is usually incrusted with a dirty, greenish, or yellowish pultaceous substance, with here and there a small, fiery-looking, exquisitely sensitive granulation. Sinuses often extend from the main ulcer in different directions, and it is not uncommon, when the destruction has been at all extensive, to see some of the affected glands lying in a partially detached state at the bottom of the sore, perhaps adhering merely by a few shreds of connective tissue.

An ulcerated bubo may take on *phagedenic* action, extending more or less rapidly in different directions, especially in persons of an unhealthy constitution. This epiphenomenon may show itself soon after the swelling has been laid open, or not until after the lapse of several weeks or months. It is usually characterized by severe pain, by a thin, profuse, sanious discharge, and by a foul, pultaceous state of the sore, along with an irritable condition of the system, want of appetite and sleep, and disorder of the alimentary canal.

Finally, a virulent bubo may run into *gangrene :* sometimes before ulceration sets in, but usually not until afterwards. Such a termination is most liable to occur in the lower classes of patients, the inmates of cellars, prisons, almshouses, and other filthy places, and often produces the most frightful ravages, causing extensive destruction of the skin and connective tissue, as well as, in some cases, of the muscles of the abdomen. The symptoms are generally very severe and the disease often proves fatal, the sufferer, meanwhile, forming a most loathsome and disgusting object.

Diagnosis.—Chancroidal bubo is liable to be confounded with bubo from other causes, and hence it is by no means always easy to determine the diagnosis, desirable as it is that there should be no mistake upon a subject of such practical moment. There are a few points in connection with these classes of swelling which are deserving of attention as means of discrimination. In the first place, the surgeon must carefully consider the history of the case. A chancroidal bubo seldom comes on before the end of the second week from the primary disease, and in many instances, indeed, not until a much later period. In the common bubo, the swelling ordinarily supervenes within a short time after the application of the exciting cause. Thus, a boil upon the nates, or a corn, bruise, or other injury of the toe, is usually followed by a bubo during the first three or four days after the commencement of the local affection. Secondly, useful information may be obtained from a consideration of the duration of the swelling. A chancroidal bubo usually lasts a number of weeks, often, indeed, several months ; an ordinary bubo, on the other hand, generally promptly disappears with the cause that induced it. Thirdly, the chancroidal bubo often suppurates and ulcerates ; the common bubo seldom, and then only or chiefly in persons of a scrofulous and broken constitution. Fourthly, the matter of the chancroidal bubo is always inoculable ; of the common, never. Finally, the chancroidal swelling is always situated above Poupart's ligament, or partly below and partly above ; the non-specific usually below, and generally affects a greater number of glands.

The syphilitic bubo generally appears at the same time as the induration of the base of the initial lesion, and involves a number of glands, which are distinct, freely movable upon one another and the surrounding tissues, and densely hard. It rarely suppurates, and its secretion is not autoinoculable.

The scrofulous bubo occurs only in persons of a scrofulous diathesis, mostly in children, prior to the age of puberty. It commonly affects a considerable number of glands simultaneously, and they remain enlarged for a long time, being very hard and lobulated, and slowly tending to suppuration. The matter is of a yellow-greenish hue, and collects in several little abscesses, which, bursting, leave ill-conditioned ulcers, with thin, bluish, undermined edges, and a thin, sanious, irritating discharge, destitute of inoculable properties. The bulk of the swelling is usually situated below Poupart's ligament, at the upper and inner part of the thigh ; and traces of strumous disease generally occur in other parts of the body.

Treatment.—The treatment of bubo must be conducted upon the same general principles as that of the primary sore, of which, as already stated, it is simply another form. If the disease be seen early, before there is much inflammatory action or any decided tendency to suppuration, the abortive treatment will come into play, consisting of the free application of tincture of iodine, and of concentrated compression, either with a truss, a piece of lead, a bag of fine shot, a series of linen pads, or, what is better than anything else, layers of wet sponge frequently renewed, and secured with the spica bandage. There are few cases of incipient bubo which can resist the combined influence of these remedies, if properly managed. If the compression prove painful, it must be moderated, or temporarily pretermitted. Occasionally the treatment is advantageously preceded by the application of leeches placed around the periphery of the affected glands.

If the disease has already made considerable progress, iodine and compression will probably prove insufficient, and then more active measures will be required. Of these, the most efficient is the formation of an eschar upon the most prominent portion of the swelling by means of the Vienna paste, applied as in making an ordinary issue, or a solution of bichloride of mercury, in the proportion of twenty grains to the ounce of alcohol. The skin having previously been elevated by a small blister, a compress, wet with the lotion, is firmly bound upon the raw surface, and retained for two hours, when it is replaced by an emollient poultice or warm-water dressing. The pain produced by this aplication is excessive, and hence the paste usually deserves the preference, especially as the mercury does not possess any special therapeutic advantages. The new action created by the caustic neutralizes or overwhelms the preëxisting, and rapidly destroys the specific disease.

When suppuration is threatened, or inevitable, it should be expedited by the usual means, especially emollient poultices, aided by recumbency and a relaxed position of the lower extremity. As soon as fluctuation is observed, the parts must be freely divided, even if the matter be deep-seated, in order to give full vent to the confined fluid. A tent is kept in the opening to prevent closure of the edges. Two incisions should always be made, one in the direction of Poupart's ligament, and the other perpendicularly, or in the direction of the linea alba, to afford thorough drainage. The operation is sometimes attended with considerable hemorrhage, chiefly, however, of a venous nature, and, consequently, easily arrested by pressure and quietude. If troublesome, the cavity should be packed with lint, wet with Monsel's solution. When the suppurative process is very slow and imperfect, the most appropriate application is a large blister, retained sufficiently long to produce thorough vesication, and dressed with an emollient poultice. When the accumulation of pus is very large, it has been proposed to effect its evacuation, not by incision, but by the aspirator, or by numerous punctures, on the ground that it would be less destructive to the integument than the more common operation. I have not, however, found this to be so in my own practice. On the contrary, the skin and connective tissue are generally so much detached and impoverished as to render it impossible to preserve them with any reasonable prospect of ultimate reunion. Hence, I am always in favor of a free division; nor do I hesitate afterwards to remove such portions of integument as may seem to act obstructingly to the reparative process by overhanging the surface of the ulcer, and thus interfering with its medication. If sinuses form, they must be laid open, early and freely, in the usual manner; or, if they are very deep and tortuous, injected with some stimulating lotion, tented, and compressed. Fungous granulations are repressed with escharotics, as sulphate of copper or acid nitrate of mercury, or, what is better, the scissors. Loose glands are removed with the scoop or the knife. If the constitution is impaired by protracted suffering and confinement, tonics and change of air will be required; and in all cases proper attention must be paid to the diet, bowels, and secretions. If phagedena or gangrene supervene, the same line of treatment will be demanded as under similar circumstances in the primary disease.

II. SYPHILIS.

SECT. I.—GENERAL CONSIDERATIONS.

The term syphilis is applied to a disease which, commencing in the genital organs in the form of a sore of a specific character, invades the lymphatic glands of the groin, the cutaneous and mucous tissues, and finally also the bones, cartilages, fibrous membranes, and viscera, leaving upon each and all of them, as well as upon the system at large, a peculiar and distinctive impress. These different parts, however, do not all suffer at one and the same time; on the contrary, it would seem to be necessary that the poison upon which the infection depends should lie for a certain period in the tissues in which it has been deposited, in order to enable it to prepare itself for further action. Thus, in the first instance, the operation of the poison is limited to the genital organs and the lymphatic glands of the groin. After having lingered here for some time, varying, on an average, from six to seven weeks, the cutaneous and mucous surfaces begin to suffer; and at a still later period, generally from six to eighteen months, the bones, cartilages, fibrous membranes, and viscera are attacked. In this manner are produced three distinct groups of syphilis, known, respectively, as primary, secondary, and tertiary. To these has lately been added another, the quaternary, in which the disease is seated, mainly, in the nervous

system and the viscera, as the brain, lungs, heart, liver, spleen, kidneys, and testicles, the latter of which may be regarded as external viscera.

It is not my intention here to enter into an account of the history of the origin of syphilis; such an undertaking, besides involving an immense amount of research, ethnological, literary, and biblical, would be entirely out of place in a treatise of this description, limited as it is to the practical details of surgery. I may remark, however, that, in my opinion, it is great folly to regard the disease as of modern origin. If the records of antiquity could be fully explored, it cannot be doubted that we should discover the most satisfactory and irrefragable evidence of the existence of syphilis in the most remote periods of society, now aggravated and now kept in abeyance, according to the habits and morals of the various races of mankind, and the nature of the climate of the countries in which they dwelt. If the history of the inner life of Sodom and Gomorrah could be laid open to our scrutiny, it would furnish a page to the history of prostitution as loathsome and disgusting as any afforded by the vilest and most depraved cities of the present day, either in the Old World or in the New.

Experiments performed by Turenne, Diday, and others, conclusively show that while chancroid may be propagated from man to the inferior animals, as the monkey, cat, rabbit, and horse, and from these back again to man, in no instance has inoculation with the virus of a chancre succeeded in producing a similar local affection or constitutional involvement.

The disease invariably arises from inoculation with a peculiar *poison*, known as the poison of syphilis or chancre. Of the precise nature of this poison all that is known is, that, when inserted into the tissues, it engenders a disease similar to itself, the resulting sore yielding a virus, in every respect, identical with that which furnished it in the first instance. Like the poison of smallpox, it is a peculiar poison, capable of reproducing itself, and of multiplying itself by zymosis. The smallest inconceivable atom, brought in contact with an appropriate surface, speedily develops a disease which, if permitted to progress, may occasion the most horrible consequences, both local and constitutional, and so contaminate the solids and fluids as to render it transmissible from the parent to the offspring. As a little yeast may impregnate a large mass of dough, and cause a ferment that shall affect every particle of gluten entering into its composition, so a little syphilitic virus, so minute as to be utterly inappreciable by our senses, may affect the whole system, and poison every avenue of life and health. Zymosis having fairly commenced, it is impossible, in any case, unless proper means be adopted to counteract it, to say when it may cease, or what may be its ultimate effects.

The specific property of the syphilitic virus is not destroyed for a number of weeks, if the secretion with which it is combined is preserved in a well-corked vial; resembling, in this respect, the virus of vaccinia and variola. Sperino relates a case where the matter, dried upon the point of a lancet, was successfully inoculated at the expiration of seven months. It is rendered inert by chemical agents, and also by gangrene of the tissues infected with it.

The virus does not seem to have any particular predilection for age, sex, temperament, or occupation; all are alike liable to be affected by it. Previous disease does not prevent its action. It produces its peculiar impression most readily when applied to a clean ulcerated surface, an abrasion, or a recent wound; but inoculation may take place independently of these circumstances, simply from the introduction of the virus into a mucous follicle, which thus serves to entangle and retain it until its structure is brought thoroughly under its influence. When the part to which the virus is applied is perfectly healthy, several days may elapse before it is impregnated; or it may even escape entirely, the matter which contains it either not being able to penetrate its surface, or being wiped off before the occurrence of absorption. For the same reason a person thus situated may communicate the poison to another so as to give rise to a chancre, while he himself experiences no ill effects. Such a result not unfrequently occurs in women, from the entanglement of syphilitic matter in the folds of the mucous membrane of the vagina, from which it is afterwards transferred to the virile organ in the act of copulation.

The syphilitic virus may be communicated in various ways; first, and most commonly, by sexual intercourse; secondly, by kissing or sucking, through the agency of a mucous tubercle on the lip, tongue, or nipple; thirdly, by tatooing, as in the cases recorded by Josias and Maury, the pigments having been mixed with the saliva from a person affected with mucous patches of the mouth; fourthly, by unnatural connection, giving rise to chancre of the anus and perineum; fifthly, by linen, towels, pipes, spoons, toys, tumblers, pencils, bank-notes, and other articles; sixthly, by surgical instruments, sponges, and

dressings; seventhly, by chamber-pots and water-closets; and, lastly, by the fingers of the affected individual. In this manner a person may inoculate his own lips, nose, eyelids, or any abraded, raw, or open surface upon any portion of the body. In this way, too, accoucheurs sometimes inoculate their fingers in examining women laboring under chancre of the vulva, vagina, or uterus. Syphilis has been contracted by chewing the stumps of segars; and during the late war numerous cases occurred in which it was communicated by vaccinating soldiers with lymph from infected persons. In the valley of Rivalta, in Piedmont, in 1861, forty-six out of sixty-three children suffered almost simultaneously from this form of inoculation, several of them having died before the true nature of the disease was suspected. In these cases the real agent of contagion is the blood of persons in the secondary stage of the affection, which is mixed with the lymph; and the blood corpuscles of the menstrual discharge of syphilitic women, is declared by Dr. Hyde, of Chicago, to be not an unfrequent source of contagion.

The fact that the semen of a man laboring under constitutional syphilis is capable of communicating the disease, has long been familiar to practitioners. It is also a well ascertained fact that there are certain urethral discharges, occurring in persons affected with syphilis, which are of a contagious character, and therefore capable of imparting the disease to a healthy female, or to one who has never suffered from syphilis. Such fluids, mixing with the semen in its passage along the urethra, are supposed by Mr. Henry Lee, of London, to be a not unfrequent cause of hereditary syphilis.

SECT. II.—PRIMARY SYPHILIS.

Primary syphilis consists, as already stated, of chancre and bubo, that is, of the initial lesion, and of an induration of the lymphatic glands in anatomical relation with the former. The disease is not, as was formerly supposed, strictly local when it is limited to these phenomena, but it is an evidence that the system is already contaminated by the syphilitic virus.

1. CHANCRE.

If what is said under the head of chancroid be true, it follows, as a logical sequence, that there is only one truly syphilitic sore, the most appropriate name for which is chancre. The phrase, "initial lesion," introduced by the German writers, is also quite expressive, and is much in vogue in this and other countries. Hunter described a form of chancre which has long been known by his name, the characteristic feature of which is great hardness with an excavated condition of the resulting ulcer. This form of chancre mentioned with special emphasis by many of the earlier writers on venereal diseases, must have been much more common formerly than it is at present; for experience has shown that, while induration exists in almost every case of the disease, the form of sore here referred to is comparatively infrequent. Thus, of 170 cases tabulated by Bassereau, superficial erosions existed in 146, and circumscribed sores with abrupt edges, or sores falling under Hunter's distinction, only in 24.

Syphilis occurs, as a primary disease, under two varieties of form, the acquired and the inherited; the former, as the name implies, is the effect of direct contact in which infected tissue is brought in relation with sound tissue, whereas the latter is the result of the contamination of the ovum either in the act of copulation or at a variable period after that act. In either case, the cause of the disease is a peculiar virus, known as the syphilitic virus, the precise nature of which has never been satisfactorily unravelled either by chemical analysis or microscopical observation. All that is really known respecting it is that it is a zymotic virus, similar, in this respect, to the virus of measles, scarlatina, or variola, and capable of producing a constitutional impression which, as a rule, secures immunity to the system from future attacks. It differs, however, from the ordinary zymotic diseases in the fact that it passes through distinct stages of development, and that its germs may forever remain in the system, liable to be called at any time into activity, if, from any cause, the person experiences great impairment of his health. It is, moreover, transmissible from the parent to the child.

The site of chancre is very extensive, more so, indeed, than that of chancroid. In the male the parts most frequently involved are the head and prepuce of the penis. Of 476 cases of this disease observed at the Hopital du Midi in 1856, 314 occurred in these situations. The skin of the penis was affected in 60 cases, and various parts of this organ in 11 more; the meatus in 32 cases, the interior of the urethra in 17, the peno-scrotal angle in 11, the anus in 6, the lips in 12, and the tongue in 8; the nose, pituitary membrane,

eyelids, fingers and leg each in 1. I have repeatedly seen chancres on the fingers in medical men, and chancre of the lips is by no means uncommon in the women treated for venereal diseases at the Jefferson Medical College Hospital. In the female sex chancre is most frequently witnessed upon the labia and nymphæ, the entrance of the vagina, meatus, fourchette, and anus. In suckling women the nipple is occasionally inoculated by an infecting infant. The uterus rarely suffers from chancre.

The question, whether chancre has a period of incubation has been so often answered affirmatively that it would be idle to discuss it in a work on surgery. All zymotic diseases have a period of this kind, and syphilis forms no exception to the general law. In syphilis it averages from two to three weeks, but it often extends to a much later date, and as remotely even as fourteen weeks; on the other hand, in exceptional cases, the period is only ten days. It is not to be inferred from the word " incubation" as here used that the virus of syphilis lies perfectly latent in the inoculated part from the time of exposure to the appearance of the sore; on the contrary, it begins its zymotic operation within a very brief period, and rapidly penetrates the system, the entering wedges being the lymphatic vessels. This effect is always, other things being equal, produced more promptly when the infecting matter is brought into contact with an open, ulcerated, or abraded surface than when it is entangled in the orifice of a mucous crypt or sebaceous gland, in either of which it may lie literally in a state of latency for several days, if not several weeks.

Chancre, as already stated, appears under no exclusive form, but is susceptible of great variation, assuming at one time this feature and at another that. The superficial form is most common on the mucous membranes, especially in those situations which are free from friction and exposure to the air and other sources of irritation; it is generally of a rounded or oval shape; the base is slightly depressed, seldom excavated, smooth or even partially polished, and of a reddish, livid, or grayish color. Its size varies from that of a split pea to that of a five-cent piece. It is generally solitary, has no areola and, unless irritated, does not furnish any pus globules, but only a thin, serous secretion, small in quantity and destitute of autoinoculating properties. On the skin the ulcer is generally more depressed, and its edges more defined; it is also more liable to be covered with scabs, and to give rise to appearances closely simulating certain forms of secondary eruptions, as the pustular and ecthymatous. In both structures, the mucous and cutaneous, induration constitutes a conspicuous if not an invariable concomitant of the ulcer, as is well shown in fig. 78, from a hospital patient.

The number of chancres offers a remarkable contrast to that of chancroids; while the latter are generally multiple the former are most frequently solitary, certainly in three cases out of every four. Such, at all events, must be our conclusion if we may credit the

Fig. 78.

Indurated Chancre.

statistics of 1584 cases compiled by Fournier, Clerc, Hammond, and Le Fort, of which 465 only were multiple. Occasionally the number ranges from two, three, five, or even six, and in one remarkable instance, observed by Fournier, there were as many as nineteen.

Chancre, as might be supposed, is liable to certain modifications in its appearances, depending upon various causes, local and constitutional, individual peculiarity, and, no doubt, also upon the character of the poison itself; for there can be no question that it is much more virulent in some cases than in others. In the so-called Hunterian chancre, fig. 79, the ulcer is hollow as if it had been scooped out of the tissues, and incrusted with a layer of very firmly adherent fibrin, of a dirty-grayish color. The edges are hard, slightly elevated, and inclined somewhat slopingly from within outwards. The base is well defined and remarkably hard, feeling, if pressed between the thumb and finger, like a button of fibro-cartilage, or, to employ the comparison of Benjamin Bell, like a split pea set in the structures immediately around the chancre. This form of sore is, as already stated, most common on the skin, but is also sometimes met with on the head of the penis, the inner surface of the prepuce, the labia, uterus, and lips.

A diphtheritic condition is very common in chancres, and is especially liable to occur when there is, from any cause, overaction in the sore; the plastic matter which gives

rise to this appearance is usually deposited in a thin, firmly adherent layer, more or less moist, and of a dirty, grayish, or greenish color. The neighboring structures are more or less inflamed, and often highly sensitive, if not actually painful.

A chancre occasionally appears as a hard knot or tubercle, of an indolent character, free from pain, and indisposed to take on ulcerative action. The frenum and edges of the prepuce are its most common seats.

Fig. 79.

Hunterian Chancre.

A chancre never suppurates except when it is irritated by friction, exposure, want of cleanliness, or improper applications. When this is the case it pours out pus, in greater or less quantity, precisely as any ordinary sore, and the fluid thus furnished may, by admixture with the natural secretion of the chancre, become inoculable. It is a fact worthy of notice that chancre and chancroid may coexist, or be ingrafted, so to speak, the one upon the other. In such an event, one sore will be hard and the other soft, or, if the ulcers run together, one part will present this feature, and the other that. This form of chancre is probably of more frequent occurrence than it is generally supposed to be. Professor Sigmund, of Vienna, who has made it a special study, inoculated the pus of a chancroid upon the infiltrated tissues of a hard papule with an unbroken surface, and in less than two days an open sore was established, one part of which was soft, while the other, or deep portion, exhibited all the characteristic features of a Hunterian chancre, and was the seat of the true syphilitic virus.

The natural color of a chancre is reddish or grayish, but this is liable to be changed by overaction of the part, however induced. A muddy, darkish, or blackish appearance is by no means uncommon, especially in persons of dilapidated constitution or intemperate habits, and is always denotive of the existence of molecular gangrene. Phagedena or gangrene in mass, as it may be termed, is occasionally witnessed under similar circumstances, and may, if not speedily arrested, be productive of great havoc. Nevertheless, such occurrences are far less common in chancre than in chancroid; and the serpiginous ulcers, so often witnessed in chancroid in persons of deteriorated health, are rarely seen in similar conditions in chancre.

What is known as the *multiple herpetiform* chancre, originally described by Dubue, is a rare form of ulcer occasionally met with on the head and foreskin of the penis and on the labia and vulva, occurring in the form of superficial erosions, of a rounded shape, of a deep red or coppery hue, and originally hardly the size of a millet-seed, but liable to enlarge as they progress, and finally to coalesce or run into each other. They are very sensitive, bleed readily under rude contact, and generally, as their name denotes, exist in considerable numbers, as many as a dozen, fifteen, or even twenty, coexisting or forming in more or less rapid succession. From ordinary herpes with which they are liable to be confounded they are distinguished by their smooth and shining surface, by their slightly indurated base, by their persistency, which is seldom less than four or five weeks, by the absence of itching, and by the induration of the lymphatic glands of the groin.

Under the name of *infecting balano-posthitis* Mauriac has given an account of a rare form of chancre, which consists essentially in a thickened, reddened, and excoriated condition of the mucous membrane of the prepuce and head of the penis, attended with more or less induration, tumefaction, and cell-infiltration. The disease is characterized by its chronicity, and by more or less involvement of the neighboring lymphatic glands; circumstances which readily distinguish it from ordinary balano-posthitis.

Finally, there is what Lancereaux, Bumstead, and others have described as the *dry chancre*, an extremely rare form of the disease, in which the head of the penis is incrusted with patches, of a round or oval shape, of variable size, and of a whitish or grayish color, beneath which the superficial structures are more or less thickened, indurated, and filled with cells. Dr. P. A. Morrow has published the particulars of a rare case of chancre, in which the head of the penis was covered with a membranous hood; but in this instance the deposit was moist and glistening, and, although firmly attached, unaccompanied by hardness or ulceration. The disease pursued an indolent course, and was followed by secondary symptoms.

Induration forms a prominent feature in chancre, and hence is of great diagnostic value; indeed, it is the most characteristic sign of the disease. It is seldom observable before the eighth or tenth day from the exposure, and never, as a rule, attains its maximum development under a fortnight. Of 261 cases of chancre treated by Sigmund, the induration occurred on the ninth day in 71, on the tenth in 84, on the fourteenth in 76, on the seven-

teenth in 15, on the nineteenth in 12, and on the twenty-first in 3. In 438 cases reported by Le Fort, the average period was nineteen days; in 5 cases the induration was noticed between the second and fourth days, and in 60 between the fifth and eighth days. Diday, in 19 cases, found the mean duration to be fourteen days, while Chabalier, in 96 cases, was induced to place it at eighteen days. Similar testimony in regard to the tardy development of chancre has been furnished by Castelnau, Gibert, Rollet, Bumstead, Bellehomme, Martin, and many other syphilographers. The fact, indeed, is familiar to every experienced practitioner. In rare examples the period of its appearance has been known to exceed one month. Occasionally the induration precedes the ulceration; and it is not uncommon for it to persist long after the primary sore is healed; or it may disappear, and then recur, perhaps a second, third, or even a fourth time, with or without reopening of the old sore. In exceptional cases the induration constitutes the only evidence of the initial lesion of syphilis. Its approaches are usually very insidious, and unaccompanied by any of the evidences of ordinary inflammation. Its boundaries are always well defined, but its consistence is generally more or less influenced by the seat of the chancre, or the nature of the affected structures. Thus, on the skin, it always, as a rule, in the fully-developed chancre, imparts the sensation, if pressed between the thumb and finger, of a hard lump or piece of fibro-cartilage. This form of induration is especially conspicuous in the so-called Hunterian chancre, striking illustrations of which are so constantly met with in chancre of the lips, and, occasionally also, upon the head of the penis, as well as in other localities. In chancres, on the other hand, seated in the mucous membranes, and presenting themselves as superficial erosions, the induration is commonly of the parchment-like variety, the affected structures feeling as if they rested upon a layer of that substance. In exceptional cases, as rare as they are generally difficult of accurate discrimination, there is an entire absence of induration; or, in other words, the chancre is soft, and yet not any the less infecting.

The cause of the induration is the new growth of connective tissue, which surrounds the chancre evenly and completely, forming around it a distinct and well-defined wall, without any blending into the neighboring parts, differing thus from an ordinary inflammatory deposit which is always lost insensibly in the circumjacent structures.

The duration of chancre varies in different cases and under different circumstances, but, as a general rule, it is somewhat less than that of chancroid. If the person is in sound health at the time of the exposure, and guards himself well afterwards, he will be likely to fare much better than one in an opposite condition. How far the mercurial treatment, to be discussed by-and-by, may influence the duration of chancre is still an open question. As a rule, no patient is safe so long as the ulcer is not in a healthy granulating condition. It is now fully established that one attack of chancre effectually protects both the part and system against a second attack, the poison of syphilis thus resembling, in its habits, the poison of variola and similar diseases; chancroid, on the contrary, exercises no such influence, one attack affording no immunity against another. Artificial inoculation performed upon persons previously effected with syphilis produces no positive effects, conclusively showing that there is no susceptibility to future invasion.

Does a chancre ever leave any *cicatrice* or scar? This question is one of great interest both in a diagnostic, therapeutic, and juridical point of view, and should therefore always be carefully considered. In the more simple forms of the disease, in which there never is any appreciable loss of substance, the process of cicatrization effectually obliterates all traces of the chancre, save, perhaps, in the skin, in which there is occasionally a slightly bronze-colored hue; but it is far different when such a sore has been assailed by phagedenic, gangrenous, or sloughing action. Here, as there is always more or less destruction of tissue, a scar, more or less depressed, indelible, and a few shades lighter than the adjacent surface, is inevitable, and always, at least as a rule, easily detectable. No patient can be said to be entirely well so long as the cicatrice of such a sore remains hard: the induration is an evidence that some of the virus still lurks in the affected structures, where it may at any moment be fanned into activity.

The complications of chancre are inflammation, phagedena, and gangrene, but these affections are not so common as they are in chancroid, under which head they are fully described. The affections of the lymphatic glands and vessels will be considered in the succeeding section.

Diagnosis.—The subjoined table shows at a glance the typical differences between chancre and chancroid. The most reliable signs of the former are the period of incubation, induration of the associated lymphatic glands, and induration of the base of the sore.

CHANCRE.

1. A constitutional disease, dependent upon the inoculation of a peculiar poison the product of a chancre, a mucous patch, or of contaminated blood.
2. Generally seated on the genital organs, but may also occur on the lips, nipples, fingers, and other structures.
3. Has a distinct period of incubation, varying on an average from eleven to twenty-one days.

4. Begins as an excoriation, or induration, generally in the form of a papule, or a tubercle which, in time, undergoes ulceration.
5. Advances slowly and heals rather rapidly.
6. Is generally single; multiple, if at all, usually so from the start from primary inoculation.

7. Form; round, or oval, generally as a superficial erosion; flat or slightly elevated; rarely deep, or excavated.
8. The floor of the ulcer smooth, red, and of a livid, or copper color; often grayish, muddy, or slightly greenish, especially if incrusted with plasma.
9. Edges sloping, as if the sore had been scooped out; flat, and adherent.
10. Discharge scanty and serous, and autoinoculation either impossible or effected with great difficulty.
11. Induration almost invariable, especially in men; sometimes absent in women; cartilaginous or parchment-like in its feel; circumscribed, movable, indolent, and persistent.
12. Generally insensible; hence often overlooked.
13. Occurs seldom, if ever, more than once in the same individual.
14. Seldom invaded by phagedena or gangrene.

15. Induration of the lymphatic vessels, common, especially in those of the penis.

16. Neighboring lymphatic glands indurated, painless, and freely movable; suppuration uncommon, and pus never autoinoculable.

17. Difficult of eradication, but may be improved by mercury and other remedies.
18. Is peculiar to the human race; at least the results thus far obtained tend to this conclusion.

CHANCROID.

1. A purely local affection, due to the inoculation of a contagious matter, wholly different from that of chancre.
2. Most common on the genital organs, whence it may extend to the groins, perineum, and the anus, especially in women.
3. The action of the poison begins at once, the ulcer usually attaining its full development and specific character by the end of the third to the fifth day.
4. Appears originally as a pustule, sore, or ulcer, and retains the character of an open surface throughout.
5. Progresses rapidly but heals slowly.
6. Frequently multiple, if not from the start, soon rendered so by autoinoculation from diffusion of the secretion.
7. Irregularly rounded, oval, or fissured, the sores often running into each other, and accompanied by a tendency to burrow.
8. Dirty-yellowish white, grayish, or pale pink; ragged, or worm-eaten.

9. Edges abrupt or perpendicular; eroded, and often undermined.
10. Abundant, thick, purulent, and readily autoinoculable.

11. Always wanting, except when the sores have been irritated by caustic or other harsh applications.

12. Always more or less painful.

13. May occur an indefinite number of times.

14. Inflammation often runs high, and may then end in destructive action, especially in broken-down persons.
15. Very uncommon, but may attend when the sore has been unduly inflamed by local irritants or a bad state of the system.
16. Bubo exists in about one-third or one-fourth of the cases; disease always inflammatory, and tending to suppuration; the pus frequently autoinoculable.
17. More or less amenable to simple local and general remedies.
18. May, it is believed, be transmitted by inoculation to some of the lower animals.

Chancre of the Urethra.—Chancre occasionally attacks the urethra; probably much oftener than is generally supposed, although its relative frequency to chancre of the prepuce and head of the penis has not been satisfactorily determined. Of 171 cases of chancre in males observed at the Hôpital du Midi at Paris in 1856, 17 involved the urethra and 32 the meatus. The fact that chancre is liable to occur here was not known, even to the most enlightened syphilographers, until within a comparatively recent period, and it is, therefore, not surprising that many of them should have considered gonorrhœa as capable, in some cases, of giving rise to secondary symptoms. The sore being concealed in the urethra, the discharge which attended it was regarded as being exclusively the product of gonorrhœa, and the ignorance which existed upon the subject would probably never have been removed if it had not been for the practice of inoculation. The numerous experiments which have been performed upon the subject have proved, beyond the possibility of doubt or cavil, that gonorrhœa is a merely local affection, and that, whenever any constitutional syphilitic phenomena occur as the consequence of a urethral profluvium these phenomena are due, not to the effects of gonorrhœa, but to those of urethral chancre.

Chancre of the urethra is generally situated immediately behind the meatus, or in that

portion of the canal which corresponds with the glans ; I have, however, repeatedly met with it on the lips of the external orifice, and in a young gentleman, recently under my care, there was a well-marked indurated chancre at least two inches behind the anterior extremity of the tube. The disease occasionally, although very rarely, extends over nearly the whole of the urethra, as far back as the neck of the bladder.

The period of latency of chancre of the urethra is much longer than in the ordinary form of the disease, being seldom less than three and a half or four weeks. The reason of this would seem to be that the specific virus, entangled in some of the lacunæ of the canal, is incapable of exerting the same rapid influence as when it is brought in contact with an abraded surface upon the head of the penis. Moreover, it is extremely probable that only a very small quantity of the poison generally finds its way into the urethra, and that, consequently, it has great difficulty, not merely in effecting a secure lodgment, but in so multiplying itself as to enable it to produce ultimately an explosive effect upon the mucous and submucous tissues. The urine, passing along the tube soon after the intromission of the specific fluid, generally either washes it entirely away, or, combining with it, effectually neutralizes its active properties.

The discharge attendant upon chancre of the urethra is always much less copious than in ordinary gonorrhœa ; it is also more thin, and of a lighter color, unless the accompanying inflammation is unusually severe, when it may be both profuse and of a thick, bloody character, or thick and yellow with a greenish tinge. There is generally some degree of scalding in micturition, though hardly ever so much as in gonorrhœa, and the site of the chancre is nearly always indicated by a sense of hardness, or a kind of lump easily distinguished by the thumb and finger. When the disease affects the anterior extremity of the tube, it is not uncommon to find great induration of the whole head of the penis, with a red and phlogosed appearance of its mucous covering, and considerable tumefaction of the prepuce. Morbid erections are not only frequent, but often very painful and troublesome. The disease is usually chronic, rarely gives rise to fever, and is always followed by constitutional symptoms. Bubo is seldom so distinctly marked as in chancre of the penis. More or less contraction of the urethra, especially in neglected or protracted cases, is an invariable sequence.

The diagnosis of chancre of the urethra is often difficult. It is easy enough when the ulcer is situated at the lips of the meatus, or just behind the orifice, the mere separation of the edges of which will then be sufficient to bring it fully into view. When located farther back, its existence becomes a matter of doubt ; for, although the accompanying induration may be very distinct, yet as a similar condition may be present in gonorrhœa, or stricture, as a consequence of a deposit of lymph into the submucous connective tissue, no useful deduction can be drawn from it. The most valuable rational symptoms are, the unusual latency of the poison, or the extraordinary length of time which intervenes between the impure connection and the outbreak of the disease, the remarkable obstinacy of the attack, resisting, as it generally does, all the various methods of treatment commonly directed for the cure of gonorrhœa, the slight scalding in micturition, and, lastly, the frequent variation in the nature of the discharge, which is now scanty, thin, and serous, now profuse, thick, and yellow.

Chancre of the Fingers, Lips, Tongue, and Anus.—Chancre of a finger may be contracted by surgeons and accoucheurs in examining, dressing, or delivering diseased women, from the accidental inoculation with the syphilitic poison. It commonly begins as a little sore or vesicle at the side of the nail, from which it gradually extends until it eventually involves its entire structure, as well as the surrounding parts. The attack is attended with great pain, discoloration, and swelling of the finger, which soon becomes bulbous and distorted, very much as in the worst forms of onyxitis ; and the ulcer itself presents a foul phagedenic or sloughing aspect. Red lines frequently extend up the arm, the axillary lymphatic glands are enlarged either alone or conjointly with that at the elbow, as well as exquisitely tender, and the general health is seriously impaired ; often, indeed, totally wrecked.

A chancre sometimes forms upon the lips ; more frequently upon the lower than the upper, as a result either of the contact of chancrous matter or of inoculation with the secretion of a mucous tubercle, as in the act of kissing, smoking, drinking, or glass-blowing. The sore is solitary, more or less oval, and characterized by a remarkably indurated base, the part feeling like a mass of fibro-cartilage. The discharge is scanty and ichorous. The whole lip is stiff, painful, and everted. Lymphatic involvement of the chin and side of the jaw is an invariable sequence.

In chancre of the tongue, it is usually the tip of the organ that is affected. The sore is very hard and indolent, but possesses no distinctive features.

In chancre of the anus the sores, which may be solitary or multiple, may be seated just at the verge of the anus, or immediately above the sphincter muscle, and are distinguished by their hardness, their rosaceous color, and their slow and painless development. Defecation is exquisitely painful, the parts are excoriated and inflamed, the discharge is thin and fetid, and, if the morbid action be not speedily arrested, abscesses are liable to form, although they seldom open into the bowel. Buboes rarely follow.

Chancres are liable to form in other parts of the body, as the nose, cheeks, eyelids, scalp, trunk, and extremities, and it is remarkable that in all these situations the sores invariably belong to the indurated variety of the disease.

The diagnosis of chancre of the fingers, lips, tongue, anus, and other portions of the cutaneous, mucous, or muco-cutaneous surface must be deduced from the history of the case, and from a careful examination of the affected structures. It should be borne in mind that a chancre of the lip may be mistaken for an epithelioma; and no surgeon should ever be in haste to amputate a syphilitic finger, when the ulcer presents a foul or sloughy aspect, inasmuch as a judicious course of treatment may promptly cure the disease.

Is syphilis a curable disease? Does it ever disappear spontaneously, or eventually lose its hold upon the system, so that a patient may be said to be perfectly well? These are grave questions, and it is much to be regretted that we cannot, in the existing state of the science, return satisfactory answers. From all the light that at present exists upon the subject, I think it may fairly be assumed that, as a rule, when a man has once been syphilitic, he will always be syphilitic; in other words, that the germs of the disease remain forever in the system, liable, under adverse circumstances, to be at any time, however remote from the primary inoculation, fanned into activity, or, figuratively speaking, to rise, like a phœnix, from its ashes. That the virus is, in exceptional cases, as rare as they are difficult of detection, completely eliminated from the constitution, is unquestionable; at all events, such is the conclusion arrived at after a thorough study of the subject in all its phases by some of the ablest and most experienced syphilographers of the present day, men who are not easily led astray by speculation or conjecture. But, although syphilis is generally an ineradicable disease, it is consolatory to know that it is no longer endowed with the virulence which characterized it in former times, and that, under proper treatment and hygienic precautions, the disease may be kept indefinitely in a state of abeyance, without danger to the patient or to his offspring.

Can syphilis give rise to pulmonary phthisis and carcinoma? Here, again, are two important questions, for the solution of which facts are still wanting. I have, myself, long been satisfied that syphilis, in persons of depraved constitution, often acts as an exciting cause of tubercular disease of the lungs and other organs, but only in cases in which there is a well-marked or deeply ingrafted predisposition to that affection. When no such state of the constitution exists, I do not believe it possible for the poison ever to produce such an effect. As to carcinoma, there are at present no facts before the profession to warrant the assertion that syphilis, in any of its forms, is capable of engendering it.

Treatment.—Much stress was formerly laid upon what was called the abortive treatment of chancre, on the supposition not yet entirely abandoned, that, if the inoculated structures could be effectually destroyed before the end of the fifth or sixth day, or the supervention of induration, which forms so characteristic a feature of the disease, all danger of the entrance of the virus into the system could thereby be averted. This doctrine is, however, no longer tenable, for, as was previously stated, there is reason to believe that the virus begins to act the moment it is brought into contact with an abraded surface, or the interior of a mucous follicle, and that, consequently, it does not, except in very rare cases, have, as was so long conjectured, any period of latency, properly so termed, however short. If we assume that this supposition is true, and few syphilographers of the present day doubt or deny it, then all abortive measures must necessarily be futile. The opinion of Ricord upon this subject is positive, and emphatic. He has entirely abandoned the practice of cauterizing and excising chancres. He considers all such procedures perfectly useless, experience having shown that even before there is any appearance of a sore or tubercle, constitutional syphilis already exists. " If," says he, " the penis were amputated on the appearance of an infecting chancre, syphilis would none the less be produced." I have, myself, repeatedly destroyed incipient chancres with the knife, acids, or escharotics, and yet in no solitary instance which I can now recall was the operation successful in preventing the development of constitutional symptoms. When

a man applies for advice, with a suspicious looking sore or abrasion, within a few hours after impure connection, the surgeon should not hesitate to employ means for the destruction of its specific properties ; the treatment might, and probably would, fail ; but if properly conducted, it could do no harm, and would, certainly, for a time at least, calm the patient's mind, an object, frequently, of the greatest importance, especially if, as so often happens, he is very nervous or excitable. If, on the other hand, several days have elapsed, or induration already exists, all such interference will be perfectly useless so far as the development of constitutional symptoms is concerned. But, although this is undoubtedly true, the operation, if early and thoroughly performed, will materially modify and abridge the local disease, and for this reason, always deserves serious consideration. When the work is decided upon, it should be done effectually, by including, if possible, some of the surrounding healthy structures. The best, safest, and least painful operation is excision, but, as few patients will submit to this, the next best thing is some acid or alkali, as the acid nitrate of mercury, nitric acid, or Vienna paste, cautiously applied, otherwise serious mischief may result. Ricord was in the habit of using carbo-sulphuric paste ; but the pain arising from it is so excessive as to render its employment highly objectionable, not to mention its tendency to spread too widely over the sound tissues. Nitrate of silver, whether in substance or solution, possesses no value as a neutralizer of the syphilitic virus. The treatment after the use of any of these agents should be conducted upon strictly soothing and antiphlogistic principles, conjoined with perfect rest until the more severe symptoms have disappeared.

Assuming, what is undoubtedly true, that, when a patient has once been thoroughly inoculated, constitutional syphilis is inevitable, the question arises, what is best to be done to render the outbreak as harmless as possible ; or, in other words, to eliminate the specific virus in the shortest time, and in the most thorough manner, from the system? It has been seen that this poison is, among other properties, possessed of zymotic qualities, by reason of which it induces rapid cell-proliferation, the effect of which is to taint alike the solids and fluids, as is shown by the various affections that manifest themselves, first, in the dermoid and mucous tissues, and, subsequently, if the disease be not timeously arrested, in all parts of the body. To prevent the germination of this poison becomes, therefore, an object of the deepest possible interest. But is it possible to do this? Upon this subject, again, as, indeed, upon every other growing out of this disease, there exists more or less divergence of opinion ; but, I think, I state the matter fairly when I assert that much may be done in every case if taken in hand at an early period after inoculation, not in preventing the occurrence of secondary symptoms, but in retarding their access, in moderating their severity, and in abridging their duration. If this can be done, a great point will be gained, a point which it is the solemn duty of every practitioner to aim at. Medicine alone will not accomplish the object. To succeed, the patient must place himself unreservedly in the hands of his professional attendant. Every hygienic measure must be called into requisition ; the diet, if plethora be present, must be abridged, the bowels freely moved, and the mind and body kept at rest. These are points upon which it is impossible to lay too much stress, or without the due observance of which it will be possible to make any efficient progress. It is worse than useless to let the patient have his own way, or to permit him to follow his accustomed mode of living. The most reliable remedy, undoubtedly, for neutralizing the poison or eliminating it from the system, is mercury, in the form of calomel, administered thrice a day, in doses varying from the third to half a grain, a short time before eating. If the patient be plethoric, it will be well to combine with each dose of the medicine a few drops of aconite, or the tenth or twelfth of a grain of tartar emetic. The effect should, of course, be carefully watched, ptyalism being sedulously guarded against, and griping and purging prevented by the use of opium and an occasional dose of oil. To prove beneficial, the treatment should be steadily maintained for at least five or six weeks. Protiodide of mercury, blue mass, or gray powder may be used as substitutes for calomel, but, as a rule, the latter deserves the preference on account of its greater certainty and more manageable character.

If mercury is the only or principal remedy capable of neutralizing, eliminating, or destroying the syphilitic virus, how long should it be persisted in to insure this desirable result? Can this question be determined in any given case, or must every case be governed by its own laws? Manifestly, the practitioner must be guided here, as in the treatment of every other disease, by general principles ; but, as a rule, founded upon long experience, and acted upon by many of the most enlightened syphilographers, it may be assumed that the use of the remedy must be continued, more or less steadily, for at least from twelve to eighteen months. Some practitioners insist upon its exhibition for a much

longer period, as two or even three years, but if such a practice is at all justifiable, it can be so only in exceptional cases, cases in which the poison has taken more than an ordinarily firm hold of the the system. When the treatment is prolonged over such a length of time, there must always be great danger of inflicting serious injury upon the system, unless the mercury is administered in the smallest possible quantity compatible with its therapeutic effects, and with the greatest possible care and judgment.

Another excellent remedy, as an eliminator of the poison of syphilis in its incubative stage, is tartar emetic, in doses varying from the eighth to the tenth or twelfth of a grain, according to the tolerance of the stomach, thrice a day. It may be given by itself, or in union with aconite and sulphate of magnesia, in the form of the antimonial and saline mixture, with the positive assurance that it will rarely, if ever, disappoint expectation. It is certainly only less potent as a neutralizer or eliminator of the syphilitic virus than mercury.

As to the iodides in the treatment of primary syphilis, experience showed long ago that they possess no curative power, whether they are employed singly or in combination with other remedies, in small or in large doses. Practitioners, ignorant of the true action of these remedies, alone employ them in this stage of the disease, and hence much valuable time is often lost, time that should have been spent in the employment of other and more appropriate remedies.

Diday, who is regarded the world over as a great authority in syphilis, and who believes that, under certain circumstances, this disease tends to self-limitation, has published the results of forty-three cases treated by the non-mercurial plan, in twenty-six of which there was never any serious constitutional disturbance, the principal phenomena consisting of a mild form of fever, acne of the scalp, roseola, and mucous patches. Although these symptoms reappeared several times in most of the cases, each successive attack was milder than the preceding one, showing plainly, as he declares, that the disease was gradually dying out or losing its hold upon the system. No tertiary symptoms were developed, and all the patients gradually regained their health and vigor. The disease, according to this writer, will be most likely to be comparatively mild when to a protracted period of incubation there is superadded a gradual diminution of the engorged lymphatic glands, followed, perhaps, only by superficial blotches of the skin, or skin and mucous membranes, separated by long intervals. When the opposite conditions exist, the prognosis will necessarily be of a more grave character, inasmuch as they go to show that the disease is more deeply rooted, or more thoroughly inlaid in the general system, the blood and solids being alike contaminated by the operation of the virus. Although there may occasionally be cases of syphilis falling under the first of these divisions, no conscientious surgeon would be likely to adopt the expectant method of treatment in a matter which so seriously concerns the happiness of his patient. An error here would not only be a blunder, but might be followed by the most lamentable consequences.

The non-mercurial treatment of venereal diseases, formerly so much lauded, is completely divested of any value that was at one time attached to it, by the fact that the distinction which is now known to exist between chancroid and chancre had not been recognized; consequently both these affections were treated on the same principles. The British surgeons, during the Peninsular wars, furnished, as they supposed, the most irrefragable proof that primary syphilis could generally be effectually cured by ordinary antiphlogistic means; and similar testimony was supplied by the hospitals of Sweden, Hamburg, Strasbourg, and other continental cities of Europe. These reports, which at one time attracted universal attention, and were accepted by many practitioners with implicit confidence in their reliability, are now only fit for the waste basket.

How mercury acts in curing syphilis, whether as a neutralizer, or as an eliminator, is still a mooted question. In all probability it acts in both ways; certain it is that its presence has been detected again and again within a short time after its exhibition, in the urine, the perspiration, the saliva, and even in the alvine evacuations. Administered in small quantities, after the system has been properly prepared for its reception, it increases the number of red globules, while it decreases the number of white, and improves the general health by augmenting the appetite and the assimilative functions. In large doses, on the other hand, or when the system is brought under its prolonged influence, it produces directly opposite effects. These facts, which accord fully with the clinical observations of every enlightened practitioner, have been placed in the strongest possible light by the researches of Liégeois, Wilbouchewitch, and Dr. E. L. Keyes, whose excellent paper on the effects of small doses of mercury in modifying the number of red blood corpuscles in syphilis is replete with interest, and worthy of the attentive study.

During this mercurial treatment, *complications* must be looked for and properly met as

they arise. Thus, if the secretions be at fault, they must be promptly corrected; and until this be accomplished, it will be well to suspend the use of the specific remedy, as it could hardly fail to prove mischievous by acting as an irritant. If febrile disturbance arise, accompanied with a strong bounding pulse and a hot, dry skin, blood may be abstracted from the arm, or, what will usually answer quite well, recourse may be had to the neutral mixture, with the addition to each dose of two or three drops of the tincture of aconite. Opium in large doses, repeated more or less frequently, and conjoined with a suitable diet and perfect rest, will be absolutely necessary if phagedena or gangrene occurs. Ricord, in such an emergency, has unbounded faith in the utility of potassio-tartrate of iron, administered every five or six hours in syrup of orange peel, or some other suitable vehicle. The exhibition of mercury is at once suspended, and every effort made to tranquillize the part and system. If the patient is anemic or greatly debilitated, the use of tonics, as quinine and iron, milk punch, and other supporting measures will be imperatively demanded, perhaps at the very outset of the treatment.

In regard to the local treatment, little, if anything, needs to be added to what is said upon this subject under the head of chancroids. Local baths, either simple or medicated, are of paramount importance; they serve not only to cleanse and soothe the affected parts, but afford material aid in moderating inflammation. The frequency with which these baths are repeated, and the time during which they should be continued, must depend upon the amount of pain, swelling, discharge, and other circumstances. I am disposed to lay much stress upon them, for it is impossible to overestimate their value in a curative point of view. The best local application, in the intervals, is a moderately strong solution of acetate of lead, or lead and opium, applied upon soft lint, or, what is much better, cotton-wool, covered with oiled silk, and renewed as often as it becomes dry or soiled. An elm poultice, simple or medicated, is another most grateful application. Blood may be taken by leeches from the groins and inside of the thighs, if the local irritation is uncommonly severe, but these animals should not, for obvious reasons, be applied to the affected organ itself. Weak lotions of acid nitrate of mercury will be found to be the most suitable remedies for arresting phagedenic or gangrenous action; and occasionally nothing answers so well as weak solutions of subsulphate of iron, combining, as this article does, the properties at once of a detergent, an alterant, and a powerful antiseptic. Languid action demands the use of stimulants, of which, according to my experience, nitrate of silver is the very best. It may be applied in substance passed lightly over the affected surface once a day, or, what I generally prefer, in solution, as five, ten, or fifteen grains to the ounce of water. A tight, unretractable prepuce should never be incised, unless it acts as a tense cord imperilling the occurrence of gangrene, when it should be freely divided at all hazard, the raw surfaces being immediately cauterized with crystallized carbolic acid, nitrate of silver, or acid nitrate of mercury. Any œdema that may be present may be treated with dilute tincture of iodine; or, this failing, with a few small punctures, hermetically sealed with collodion as soon as thorough drainage has been effected. Morbid erections are controlled with anodynes, either in the form of suppositories or hypodermic injections. When the prepuce cannot be retracted, the syringe must be freely used; first, with simple warm water to wash away the secretions, and, immediately afterward, with weak solutions of lead, alum, chlorinated sodium, or some other suitable fluid, to promote the healing of the sores. When the foreskin is sufficiently soft and yielding, it should be kept constantly separated from the head of the penis, either with dry lint, which is often the very best application that can be made, especially when the first flush of inflammation is over, or lint wet with some mild lotion, as water containing two or three drops of acid nitrate of mercury to the ounce. Dry calomel is also sometimes beneficial; and now and then weak yellow wash answers a good purpose. Ointments are, as a rule, from their liability to become rancid and offensive, less kindly borne than fluids. Here, as in the case of chancroid, it is very important to watch closely the effects of our local remedies, making such changes from time to time as the exigencies of the case may demand. He who expects to treat successfully any case of chancre, of the least severity, with any one particular remedy, will generally find himself egregiously at fault. Finally, let it be borne in mind, as a solemn warning, that all harsh applications in the treatment of this affection, as in that of chancroid, will inevitably be productive of harm, provoking irritation, increasing pain, keeping up constitutional excitement, and protracting the cure.

The indolent form of chancre is always accompanied by great induration, which often continues long after the ulcer is completely cicatrized, and constitutes a variety of syphilis peculiarly dangerous on account of its liability to be followed by unusually severe and protracted constitutional symptoms. Indeed, no patient is safe so long as the part re-

mains in this condition. It is an incontestable evidence that the virus still lingers at the original seat of the infection, and that, like a smothered fire, it may spring up at any moment into a full blaze, reëxciting ulceration, and endangering the system. It is to this form of chancre that mercurialization is so emphatically applicable : no delay should be permitted, and it will generally be necessary to carry the treatment to the extent of slight ptyalism. When the desired effect is unusually tardy, the treatment may be aided by mercurial inunctions, from one to two drachms of the ointment being rubbed on the inside of the arms and thighs morning and evening ; or, what is better, a mercurial suppository may be inserted every eight, ten, or twelve hours, the effect of the remedy being carefully watched, lest overaction should be induced. The best local remedies are very dilute tincture of iodine, lead lotions, and inunctions of mild mercurial ointment.

The treatment of chancre of the urethra is conducted upon general antisyphilitic principles. The remedies which prove so serviceable in gonorrhœa are entirely inert here, except in so far as they may be instrumental in diluting the urine and depriving it of its acrimony. When within reach, gentle cauterization with nitrate of silver will be beneficial ; indeed, in obstinate cases, hardly any other direct application will be of much avail. In the intervals of the cauterization, or, in the more intractable forms of the disease, throughout the treatment, different kinds of injections must be used, especially weak lotions of sulphate of copper, tannic acid and opium, acetate of lead, bichloride of mercury, and iodide of iron. If the sore be seated near the meatus, the opposite surfaces should be kept apart with a tent medicated with dilute ointment of nitrate of mercury ; or a small bougie smeared with this substance may occasionally be introduced. If marked induration exists, early but gentle mercurialization must be employed. Chancres of the fingers, lips, tongue, anus, and other portions of the cutaneous, mucous, or muco-cutaneous surface must be treated on general principles. Nearly all of these affections will be materially benefited by a mild course of mercury.

SYPHILIZATION.

It was supposed at one time that syphilis could be effectually eradicated from the system, after the failure of all other means, by successive inoculations with the virus of this disease. To this treatment the term syphilization, first used by Dr. Auzias Turenne, was applied. As early as 1844, this physician, in attempting to transfer syphilis from man to the monkey, was struck with the fact that, when the operation was repeated a number of times, the tissues into which the matter was inserted were at length rendered completely insusceptible to its further influence. Believing that the treatment might be advantageously applied to the human subject, he instituted some experiments in this direction, but the results were not given to the profession until after the publication of the memoir of Dr. Sperino, of Turin, in 1851. In this memoir numerous experiments are detailed apparently confirmatory of those of Auzias Turenne. Subsequently the matter was very thoroughly investigated by the late Professor Boeck, of Christiania, the results of whose labors were widely disseminated through the medical press of Europe and America.

The value of the observations of these and other experimentalists is rendered completely nugatory when it is remembered that they were unicists, or believers in only one venereal poison. Hence, since it has been determined that chancre and chancroid are essentially distinct diseases, syphilization has lost all its scientific interest and practical value : it is an exploded myth which had its origin in misconception and the grossest absurdity. As stated in a former paragraph, it is now well ascertained that the inferior animals are insusceptible of contracting syphilis, and it is equally certain that chancroid is a strictly local affection, and therefore incapable of contaminating the system ; moreover, when a person has once had syphilis, he is, as a rule, as perfectly proof against future attacks as one who has had measles, scarlatina, or smallpox.

According to Boeck, whose name is indelibly associated with the history of this operation, syphilization is justifiable at all periods of life, but should only be resorted to after the development of secondary symptoms ; for, so long as the disease is in its primary stage, inoculation would be improper, as it cannot positively be determined beforehand whether the constitution will become tainted or not. The earlier the treatment is commenced the better, and the effect will always be the more prompt and decisive, when the patient has not been subjected to any previous mercurial course, as this renders the system more stubborn to its influence, and more prone to relapses.

In performing the operation, it is immaterial whether the virus is taken from a chancroid or an irritated chancre. The parts selected for the operation are the trunk and the inside of the thighs and arms. In a few days pustules form, the matter of which is in-

serted into the skin until no further effects result, when the virus of the primary sore
must again be employed, and the same course pursued as before, until the system is ren-
dered completely unimpressible. It will sometimes require, says Boeck, the use of a
new virus five or six times, before thorough constitutional immunity is secured. The
symptoms generally begin to abate in from four to six weeks, but it may take many months
or even an entire year before the disease is perfectly eradicated; the average period being
about 134 days. It will be found, upon every repetition of the inoculation, that the pus-
tules and ulcers become less and less, and, also, that they gradually lose their specific ap-
pearance and character.

Dr. Boeck furnished the statistics of 502 cases, treated in the hospital at Christiania, of
which 429 took no mercury. Of the latter, 384 were completely cured. In the remainder
the disease relapsed. He declares that the success in his private practice was still more
flattering.

One cannot but regret in reading the contributions of Dr. Boeck and his followers that
so much time was misspent and so much labor wasted in an investigation that has been
productive of so little, if, indeed, any good. The treatment to which they devoted so
many years of fruitless toil, was not only very tedious and painful to their patients, but
so exceedingly filthy and disgusting that, even if it had had truth on its side, it could never
have been extensively, much less generally, adopted. Men would have shrunk from such
an infliction. Besides several surgeons who pursued this treatment were not only severely
censured, but prosecuted and heavily mulcted. Long before the downfall of syphilization
as a practical matter, it was shown by Mr. Lee, of London, and Dr. Lindwurm, of Munich,
that the alleged beneficial effects of the operation were due, not to any specific influence of
the inoculation, but to the depurating effects of the resulting ulcers upon the system, the
continuous suppuration serving as a salutary drain. For much interesting and valuable
information on this and other subjects of syphilization, the reader is referred to an exhaust-
ive paper of Dr. Öwre in the London Medical Times and Gazette for 1868.

2. AFFECTIONS OF THE LYMPHATIC GLANDS AND VESSELS.

These affections consist mainly in induration of these structures, liable of course to be
modified during their progress by various inflammatory accidents. More or less indura-
tion of these bodies is present in almost every case of chancre. Ricord lays it down as a
pathological law that a chancre cannot exist without induration of the associated lym-
phatic glands; "induration," he says, "follows a chancre as a shadow follows a substance."
In this opinion most syphilographers of the present day fully concur, and yet it would be
wrong to assert that this law has not an occasional exception. Bumstead, who affirms
that he has never met with a chancre which was not attended by induration of the neigh-
boring lymphatic glands, regards it as a far more reliable symptom of a chancre than
induration of the base of the ulcer itself, inasmuch, he adds, as it is more constant and
persistent, and less likely to be counterfeited by extraneous influences. The frequency of
this condition of the lymphatic glands may be inferred from the statistics of some of the
French syphilographers. Thus Bassereau found it in 355 out of 380 cases of chancre,
the diagnosis of which was confirmed by the evolution of well-marked secondary symptoms.
Of 265 examples reported by Fournier the lymphatic glands were affected in 260. Rollet
collated 26 cases of artificial inoculation with the virus of syphilis performed upon persons
previously free from this disease, in only 20 of whom induration was detected. A number
of cases have been furnished of inoculation performed upon persons previously infected
with syphilis, in every one of whom the operation afforded none but negative results. It
may reasonably be supposed that gangrene or phagedena occurring very early in the pro-
gress of chancre might oppose the development of induration, although even this admits
of doubt; and it is also very probable that cases may arise in which the induration of the
lymphatic glands of the groin and other regions of the body is so thoroughly masked by
fatty matter or diseased structure as to render its detection utterly impossible.

The glands most liable to suffer from induration are, as a rule, those in closest prox-
imity with the seat of the original infection. Thus in chancre of the penis, urethra,
scrotum, vulva, vagina, uterus, perineum, anus, nates, inferior parts of the abdomen, and
the lower extremities, the glands of the groin are involved; chancre of the lips, tongue,
mouth, and chin, is followed by induration of the submaxillary glands; chancre of the
eyelids affects the anteauricular gland; and the axillary glands suffer in chancre of the
breast and of the upper extremity. In a case of chancre of the forefinger, Bumstead
found a well-marked induration in the web between it and the thumb; and Sigmund long

ago showed that the epitrochlear gland generally becomes enlarged and indurated when the disease breaks out on the hand or forearm.

The induration of the inguinal glands usually appears as early, or nearly as early as the induration of the base of the sore, that is, from the seventh to the eleventh day, when it may be said to have attained its maximum development. In exceptional cases, it occurs later, but rarely, if ever, earlier. It may affect both groins, as when the chancre is multiple or situated on the middle line of the genital organs ; but in ordinary cases it is limited to one side. Now and then, as in chancroid, the situation is reversed, owing to the peculiar arrangement of the lymphatic vessels, those of the right side, for instance, crossing over to the left, and conversely. In the groin, as in most other localities, where the glands occur in groups, nearly all are implicated in the induration, as in fig. 80, from Cullerier,

Fig. 80.

Syphilitic Buboes.

the smaller, varying in size from that of a bean to that of an olive, being closely agregated around a larger central one. The tumor thus formed is of a hard, dense, gristly consistence, of an irregularly rounded or oval shape, freely movable, devoid of pain and even tenderness, and without any attachment to the overlying integument, which always retains its normal color. The tumor, in fact, is an indolent, insensible mass, which retains its peculiar features from several weeks to several months, without, as a general rule, manifesting any tendency to suppuration, differing thus widely and characteristically from the course of a chancroidal bubo. Suppuration is not impossible, but in such an event the matter is small in quantity, of a thin, serous or sero-sanguinolent appearance, and insusceptible of autoinoculation. Of 968 cases of induration of the inguinal lymphatic glands, consequent upon chancre, recorded by Bassereau, Rollet, and Fournier, suppuration occurred in only 35. Hence, it may be laid down, as a rule, that, when an abscess forms in the groin, it is not the product of chancre, but of chancroid or struma, or of a non-specific inflammation. The diagnosis of this form of induration may usually be readily determined by the history of the case and by a careful examination of the affected region.

Induration of the lymphatic vessels is most frequently observed upon the penis, although it is not peculiar to this organ. It manifests itself in the form of dense, firm, whip-like cords, extending from the chancre towards the root of the penis, which, however, it seldom reaches. Sometimes a knotty or tuberculated appearance is present. The change which evidently depends upon interstitial deposits in the cavity of the affected vessels, is usually contemporaneous with the induration of the chancre and of the lymphatic glands, and is characterized by its persistency, freedom from pain, and indisposition to inflammation.

No treatment is generally necessary in these affections. Any tenderness that may arise during their progress will promptly yield to rest and to the application of tincture of iodine or of a few leeches, followed by a cooling laxative. Inflammatory irritation must be relieved by the ordinary antiphlogistic measures, and matter evacuated with the lancet. In general, the induration gradually subsides under the mercurial treatment, employed to cure the primary and constitutional disease, whether occurring in the lymphatic glands or vessels, of which it is simply one of the most constant and most persistent phenomena.

SECT. III.—SECONDARY SYPHILIS.

1. GENERAL CONSIDERATIONS.

The term secondary is employed to designate that group of morbid phenomena which manifest themselves after the occurrence of primary syphilis, the period of their evolution varying, on an average, from six to seven weeks from the first outbreak of the disease. The structures which are most liable to suffer are the cutaneous and mucous, and these may be attacked either simultaneously or consecutively, or one may suffer and the other escape, according to the condition in which they may be at the time of the contamination.

Secondary syphilis is always preceded by chancre. It often comes on before the initial lesion has disappeared ; a chancre, indeed, may, to use a figurative expression, be in full bloom, and continue to furnish an abundance of specific virus, and yet the constitutional disease have already made considerable, if not very serious, progress, the skin being perhaps covered with numerous eruptions, the throat inflamed or ulcerated, and the tongue affected with tubercles, thus showing thorough contamination both of the solids and fluids. Or, the chancre may be cicatrized, but remain hard and tender, more or less of the specific poison lurking in the affected tissues, ready to ferment and break out anew from the most trivial causes. Or, the original sore may have got entirely well, but the bubo be still active, either as an indurated swelling, or as an ulcer with more or less discharge. Or, lastly, and as is, perhaps, most commonly the case, the secondary complaint does not appear until some time after the primary has completely vanished, the patient having, perhaps, in the meanwhile, imagined himself perfectly well.

It is generally impossible to determine, in advance, what effect a chancre may exert upon the system ; or, in other words, whether it will be likely to lead to mild or severe constitutional contamination. We are, however, warranted in assuming that a mild attack will follow a long incubation and a superficial chancre, and that the symptoms will be severe when the incubation is short and the initial lesion is deeply ulcerated. If the patient be stout and robust, and, in every respect, well-conditioned, both as concerns his fluids and solids, at the time of the inoculation, the poison will be much less likely to do great harm than if he be feeble and exhausted by disease, or be laboring under the strumous or scorbutic cachexia.

Secondary syphilis is, under certain circumstances, an inoculable disease. It has been shown, for example, that matter taken from a mucous tubercle, a condylomatous excrescence, a pustular eruption, or a superficial ulcer of the mucous membrane, and, in fact, even the blood will, if carefully inserted into the skin of the arm or thigh, produce a chancre essentially similar to a primary one. The period of incubation, however, is much longer than ordinary, ranging, on an average, from twenty to thirty days, and the resulting ulcer, which is always indurated, is invariably followed by indolent enlargement of the neighboring lymphatic glands.

A remarkable feature of this secondary matter is that it will not generate a chancre in the person furnishing it, or even in another infected individual. To be capable of receiving the disease the subject must be free from all syphilitic taint.

That the blood of a person affected with constitutional syphilis is inoculable is clearly established by the fact that the disease has been repeatedly propagated from an infected to a sound person by vaccination, through the agency, not of the vaccine matter, but of the blood ; for Viennois has ascertained that there is not the slightest danger of infection when care is taken to keep the lancet free from this fluid in performing the operation, or when the operation is done with vaccine matter destitute of blood.

Numerous cases of this form of infection occurred during our late war ; and the outgrowth of the disease, vaccinio-syphilitic inoculation, has been made the subject of an elaborate and exhaustive essay by Professor Jones, of New Orleans. The sad effects of this mode of propagating syphilis are well illustrated in the cases that occurred at Rivalta in Piedmont, where an infant that had been vaccinated with infected matter communicated this malady to his mother and to forty-six children. One of the children thus contaminated imparted the contagion to his wet-nurse and to seven children. The fact that a tooth transplanted from the mouth of an infected person into that of a healthy one is capable of communicating syphilis was established long ago by the observations of John Hunter and other practitioners. Even the precaution of rubbing the surface of the tooth previously to its insertion did not always prevent contamination. The infecting character of the mucous tubercle of the tongue and lip is universally admitted. Indeed, not to

carry these illustrations any further, there is every reason to believe that many of the natural and abnormal secretions of every organ, tissue, or structure affected with syphilis are capable of propagating the disease, although it may be difficult to establish the fact by artificial inoculation. From some experiments performed by Mireur it appears that the semen of a person affected with chancre and secondary symptoms is not inoculable. In four persons thus treated no specific disease followed.

In 1877 a large number of cases of syphilis occurred in this city and at Reading from tattooing the arms on different persons, the operator, who was affected with mucous tubercles of the tongue, using his saliva for mixing his materials. An account of these cases from the pen of the late Dr. F. F. Maury and Dr. Dulles, will be found in the American Journal of the Medical Sciences for January, 1878.

Secondary syphilis is not only inoculable, but also transmissible from the parent to the offspring, the result declaring itself in a great variety of affections, more or less destructive to the new being, sometimes before, at other times not until after, birth. The very stream of life is thus poisoned, so that all those who are affected by it are destined to suffer from its effects, this being at least one of the ways in which "God visits the iniquity of the fathers on their children down to the third and fourth generation." The fact that the disease is transmissible shows that the whole system of the individual is impregnated with the specific poison, every globule of blood and every particle of solid matter being impressed by it. It is this pervasive, universal influence that has led to the opinion, now very general among syphilographers and practitioners, that constitutional syphilis is seldom, if ever, completely eradicable. Once implanted in the system, its germ is probably indestructible.

Secondary syphilis is usually ushered in by well-marked constitutional phenomena. From eight to fifteen days before there is any evident disease, the patient feels uncomfortable and unwell; he is irritable, gloomy, desponding, and unable to apply himself to business; his countenance has a dull, muddy aspect; his hair is dry and rough; his limbs and joints are sore and stiff; his appetite is impaired; the bowels are costive, or alternatively costive and relaxed; the urine is scanty and high-colored; exercise soon fatigues; headache is often present; and the sleep, disturbed by frequent dreams, is unrefreshing. Gradually, after the lapse of a few days, or, it may be, suddenly, he is seized with chilly sensations, or actual rigors, followed by high fever, or by fever and profuse sweats. When the disease is fully established, an increase of temperature of several degrees is often noticeable, especially in the afternoon and evening; and cases occur, although rarely, in which the fever assumes an indistinct periodical type. The attack, constituting what is called syphilitic fever, is manifestly an effort of the system to eliminate the specific poison, and the tissues upon which it usually expends itself are, as was previously stated, the cutaneous and mucous, together with the posterior cervical glands, the morbid phenomena of the former exhibiting themselves in various eruptions, and of the latter in ulcers of the throat and in mucous tubercles of the tongue and mouth. The iris also frequently suffers from secondary involvement. The blood is always more or less affected. As a rule, syphilis diminishes the number of red corpuscles below the normal standard, while the white are, in very severe forms of the malady, greatly increased.

2. AFFECTIONS OF THE SKIN.

The syphilitic affections of the skin, the syphilides, as they have been termed by Alibert, and the syphilodermata of more recent authors, occur under at least six varieties of form, the exanthematous, scaly, vesicular, papular, pustular, and tubercular. Of these, however, the last three, from their severity and late appearance, may be regarded as appertaining rather to the tertiary order of phenomena than to the secondary. Of the other three, two are not unfrequently coincident with the primary disease, although, in general, they do not come on until some time afterwards. To these syphilides may be added certain pigmentary changes originally described by Hardy, and more recently by Fournier, Pillon, Drysdale, Fox, Atkinson, and others. The syphilitic eruptions nearly always pursue a chronic course, are more or less circular in their form, and usually exhibit a characteristic copper color, especially in their earlier stages; for, after they have existed for some time, they are very apt to assume a grayish, muddy, or bronze appearance, owing to some modification in the pigmentary matter of the skin. Although occurring upon all parts of the cutaneous surface, they are usually most conspicuous upon the forehead, nose, cheek, back, and shoulder, together with the inside of the arm and thigh, and

are attended or followed by thin, grayish scales, hard, thick, greenish scabs, narrow, superficial cracks, or well defined ulcers.

Syphilitic cutaneous diseases are generally easily distinguished from ordinary skin diseases by, first, the history of the case, especially the presence or absence of chancre, or chancre and bubo; secondly, by the concurrence of lesions of the cutaneous and mucous textures; thirdly, by the pinkish-red, yellow-brownish, or faint copper color of the affected surface, dissipated by pressure in their earlier stages, but gradually shading off into a darker permanent hue; fourthly, by the total absence of itching, or of itching in a much milder and more evanescent form than in common skin affections; fifthly, by their tendency, at least in many cases, especially when they appear as papular and erythematous rashes, to assume a circular, rounded, or ring-like form; sixthly, by their polymorphism; and, lastly, by the fact that syphilitic eruptions are often found in regions of the body in which ordinary cutaneous diseases rarely, if ever, occur. Stress has been laid by certain authors upon the odors arising during the progress of some of the syphilides, especially the ulcerating; but, although the smell may occasionally be offensive, especially if cleanliness be neglected, it is never characteristic. All these affections are, as is now well known, liable to be modified in their evolution, course, and termination by various intercurrent acute diseases, as gout, rheumatism, pneumonia, and pleurisy; and also by the use of mercury and other remedies given for the relief of the primary maladies.

1. In the *exanthematous* form, the spots are of a reddish, pinkish, or pale copper color, circular in shape, and from the size of a dime to that of a twenty-five cent piece, the intervening surface being of a muddy, dusky aspect. Although they sometimes cover nearly the whole body, they are generally most prominent on the trunk and extremities; they are rarely confluent, do not disappear under pressure, and usually pass off with a slight desquamation of the cuticle. There is a variety of this eruption in which the spots are much smaller, more irregular in shape, and of a brighter red, the color resembling that of a new copper coin. From this circumstance, and from the eruption being often somewhat confluent, like measles, it is generally known by the name of roseola. In neither of these forms is there any actual elevation of the skin.

The syphilitic exanthem may be looked for in from six to twelve weeks after the appearance of the initial lesion. It often comes on before the disappearance of the primary disease, sometimes suddenly, and without any decided premonitory symptoms; at other times gradually, and with considerable pyrexial disturbance. As the eruption fades it loses its reddish tint, and assumes a dingy, dirty, dusky, or grayish aspect. Its duration varies from ten days to six weeks. Its gradual disappearance, and its coincidence with chancre, bubo, cervical adenitis, and other marks of syphilis, either primary or secondary, together with the absence of local distress, as itching and smarting, readily distinguish it from measles and other cutaneous affections. Syphilitic fever is absent in at least one-fourth to one-third of the cases in this form of the disease. On the other hand, there are few cases in which there is not marked enlargement of the lymphatic glands in different parts of the body, especially of those of the posterior cervical region.

2. The *scaly* variety of syphilis, or psoriasis, generally appears without any febrile disturbance, from two to six months after the primary disease; it is always remarkably chronic, lasting frequently for months together, and is commonly associated with ulceration of the throat and palate, iritis, and affections of the bones and joints; forming, in this event, a kind of connecting link between the secondary and tertiary stages of the constitutional infection.

The eruption, as the name implies, manifests itself in distinct scales, or thick, hardened portions of epidermis, of a dull, opaque, grayish appearance, resting upon a copper-colored base. It generally appears in separate patches, which, although liable to occur on all parts of the cutaneous surface, are most common on the forehead, scalp, face, forearms, palm of the hand, and sole of the foot, in the latter of which they often acquire a remarkable thickness. Each individual spot is from three to six lines in diameter, of a rounded shape, ordinarily isolated, rough, and somewhat elevated beyond the adjoining level. The scale is hard, whitish or grayish, and slightly adherent; the skin underneath has a tendency to ulcerate, or to form cracks and fissures, and when, by this means, its integrity is destroyed, the affected surface becomes covered with a thick, dry, brownish crust. When the part has cicatrized, a whitish spot, somewhat depressed at the centre, marks the original site of the disease.

3. The *vesicular* variety of syphilitic disease is very uncommon; it is, in fact, by far the rarest of all the syphilides. It usually begins coincidently with the latter stages of the primary sore, or soon afterwards, in minute, circumscribed pimples, scattered over

different parts of the body, to which soon succeed small vesicles, occupied by a transparent, serous fluid, and surrounded by a reddish, copper-colored areola. From the fact that many of these are traversed by a hair, it is not improbable that they have their origin in the hair follicles. Their progress is slow, and their contents are either absorbed, or transformed into thin scales, or scabs, which, falling off at different intervals, leave the skin of a dingy, yellowish hue, with small, depressed, temporary cicatrices. The vesicles, which may be small and pointed, large and globular, isolated or grouped, are occasionally so numerous as to cover nearly the whole surface of the body. In general, they are most common on the neck, chest, and extremities, especially the superior, their occurrence on the face and head being very infrequent. They usually coincide with syphilitic disease of the throat and nomadic pains in the bones and joints; a circumstance which, together with their copper-colored base, readily distinguishes them from ordinary vesicles.

4. Syphilitic *pustules* are circumscribed elevations of the skin, occupied by pus, or sero-purulent matter, and possessing a strong tendency to ulcerate. Although they occasionally coexist with the primary disease, they seldom appear until a long time after, and, therefore, generally appertain to the third order of symptoms, their presence being always denotive of profound constitutional contamination. Their size ranges from a pea to that of a small hazel-nut. In their shape they are conical, oval, pyriform, rounded, or flattened, with a minute central depression; and there are few instances in which these different varieties do not coexist. Their number is often immense, hundreds being scattered over a small extent of surface; and, as they form successively, they may be seen and studied in every stage of their development. Each pustule reposes upon a hard, copper-colored base, and occupies the deep layer of the dermis around the hair and sebaceous follicles.

After remaining for a short time, the contents of the pustule escape, concrete, and form hard, thick scabs, of a dark brownish, or olive-brown color, pretty firmly adherent, and sometimes circularly furrowed. In the more simple cases, the scabs soon fall off, leaving merely a chronic induration, a livid, dusky, or grayish stain, or a small cicatrice; but, in the more severe, deep, circular, characteristic ulcers are exposed, with a foul, grayish bottom, and a hard, purple, and well-defined margin. In cases of the latter description, the scabs are frequently renewed, and are finally succeeded by round, indelible scars.

The pustular syphilide comprises acne, impetigo, and superficial ecthyma, and the pustules themselves may occur in groups, or be disposed separately, without any tendency, as is sometimes the case with the other, to become confluent. The matter of these pustules is capable of producing chancre by inoculation.

The pustular form of syphilis is not unfrequently associated with the tubercular and papular, but rarely with the roseolar and squamous. Severe constitutional disturbance is generally present, and, indeed, the suffering may be so great as to destroy life, the health being gradually undermined by the excessive pain and irritation of the eruption and its sequelæ.

5. *Papular* syphilis, or lichen, is characterized by the occurrence of small, hard, solid elevations, containing no fluid, and terminating nearly always in desquamation, seldom in ulceration, or in the formation of scabs. There are two varieties of the affection, one of which is acute and primary, the other chronic and secondary.

In the first variety, the eruption appears simultaneously on different regions of the body, and is completed in about forty-eight hours from the time of its invasion. The papules are extremely small, disjointed, or grouped, of a red copper color, and of a slightly conical shape, being surrounded, here and there, by violet areolæ, which are often confluent, and give the surface a characteristic tinge. Ulceration rarely attacks these papules; they soon disappear, and are followed by a furfuraceous desquamation of the cuticle.

In the other variety, the eruption is developed in a slow, successive manner, being announced by small yellow spots, which are particularly numerous on the forehead, scalp, and extremities. The papules are of a light copper color, larger than the preceding, flat, of the size of small beans, grouped, and devoid of an areola. In time, the summit of each elevation is covered with a dry, grayish pellicle, which is regenerated as fast as it desquamates until the disease finally entirely subsides. Meanwhile, the skin between the agglomerated papules undergoes important changes: it assumes a dingy yellowish color, has a dry, shrivelled aspect, and is the seat of a constant exfoliation of the cuticle.

The papular eruption is often complicated with other syphilitic affections, as inflammation and ulceration of the throat, iritis, and nocturnal pains in the larger joints.

Occasionally it coexists with an imperfectly healed chancre or bubo, or with the scaly, pustular, or tubercular form of the disease. Iritis, in particular, is an exceedingly common accompaniment.

6. Of the *tubercular* form of syphilis, the most formidable of all, there are two varieties, in the milder of which the eruption consists of small, red, copper-colored eminences, varying, ordinarily, in size between that of a mustard seed and a pea. Of a rounded, flattened, or conoidal shape, they are either isolated, assembled in groups, or arranged in more or less perfect circles; they are smooth and polished, cause little or no pain, and soon become covered with a dry, scaly crust, which is generally reproduced as fast as it falls off.

In the more aggravated form, the tubercles are inordinately large, of a deep violet hue, and encircled each by a well-marked, copper-colored areola. After continuing thus for some time, varying from a few weeks, to several months, they inflame, suppurate, and are finally replaced by deep, foul, painful, irregular ulcers, reposing upon a hard, purple base. The thick scab which usually covers these erosions is repeatedly renewed, showing, whenever it is detached, an extension of the ravages of the sore. When the tubercles are numerous, the ulcers, running together, often acquire a frightful size, and, on healing, leave white, disfiguring cicatrices.

Pigmentary changes of the skin are most frequent on the side of the neck, but no region is entirely exempt from them. Fournier met with them in the former situation in twenty-nine out of thirty cases. The color is usually more or less brownish, or dirty, milk-like, unaccompanied by any elevation or depression of the affected surfaces, coming on gradually in patches from the size of a split pea to that of a twenty-five cent piece, circular, ovoidal, or more or less irregular in shape, discrete or confluent, generally supervening late in the disease, pursuing essentially a chronic course, uninfluenced by antisyphilitic treatment, and finally disappearing, after months or even years, without any appreciable alteration in the skin. In some cases the spots have a festooned appearance, and Dr. Fox, of New York, has given a drawing in which the discoloration presented itself in the form of a distinct ring with a dark central speck. The lesion, which is most common in women of a light complexion, is liable to be confounded with leucoderma, chloasma, and several other affections of the skin, from which it may, however, in general be easily distinguished by its deeper hue, its situation, and by the history of the case.

Syphilitic *ulcers* of the skin are characterized by their rounded shape and excavated appearance, the bottom having a foul, grayish aspect, while the edges are red, ragged, and inflamed. Their tendency is to spread and undermine the surface, several not unfrequently running into each other. The discharge is thin, sanious, or ichorous, fetid, and more or less profuse and irritating. These ulcers usually have a copper-colored base, and they are nearly always sequelæ of pustules, or tubercles. They occasionally exist in great numbers. The scars left by these ulcers are permanent, of a whitish color, and extremely liable to break out into open sores on the application of the slightest irritant.

Treatment.— The treatment of secondary cutaneous syphilis may be divided into common and specific, the first being of a general antiphlogistic character, while the second has for its object the neutralization or destruction of the virus upon the action of which the affection more particularly depends, and which, so long as it continues, exposes the system constantly to new outbreaks of the disease. In most cases it will be found to be advantageous to begin the treatment with antiphlogistic remedies; for, although they may not always, or perhaps even very generally, eradicate the poison, the salutary impression which they make upon the system, by ridding it of its impurities, and restoring the secretions, greatly paves the way for the more prompt and efficient operation of any specific measures that may afterwards be deemed advisable. A disregard of this rule is probably one of the chief reasons why the mercurial treatment of syphilis is so often followed by severe tertiary symptoms, the system not being properly prepared, by a course of diet, baths, purgatives, and other remedies, for the reception and beneficial action of the mineral.

Syphilitic fever should be combated upon the same general principles as any other sympathetic fever. If the symptoms run high, as indicated by the state of the pulse and skin, and the patient is young and plethoric, blood may advantageously be taken from the arm, followed by saline, and antimonial preparations, the bowels having previously been opened by a brisk cathartic. The action of the medicines should be promoted with tepid drinks, and, if there be much pain and aching in the back and limbs, a Dover's powder, or an anodyne and diaphoretic draught will be beneficial. The duration of the fever is usually very short, the disease often yielding to very simple measures.

When eruptions appear upon the skin, the most efficient treatment, according to my experience, is the *antimonial*, or antimonial and saline. The quantity of tartar emetic given at each dose must vary from the fourth to the eighth of a grain, repeated every three, four, or five hours, with the precaution of avoiding decided nausea, which is hardly ever desired. The object simply is to produce a sedative and alterant effect. It may be administered by itself, as in the milder forms of secondary cutaneous affections, or be variously combined with other articles, as sulphate of magnesium when there is constipation, aconite when there is much arterial excitement, or morphia when an anodyne and diaphoretic action is indicated. The salutary operation of the medicine will be greatly promoted by the daily use of the tepid bath, by diluent drinks, and by a strict observance of the antiphlogistic regimen.

How tartrate of antimony and potassium operates in producing its salutary effects in secondary syphilis of the skin has not been determined. It is not improbable that it may, as mercury is supposed to do, neutralize the poison of the disease by divesting it of its zymotic qualities; or it may act simply as an eliminator, by furnishing an outlet for the poison through the various emunctories, upon all of which this medicine is known to exert more or less influence.

Tartarized antimony is particularly worthy of confidence in the treatment of secondary syphilis of the skin, but it may also be advantageously exhibited in the various affections of the mucous membranes, although its effects here are generally less apparent. The remedy, however, is not infallible, and hence, when the disease is unusually rebellious, it should be replaced by mercury, given in the same manner, and with the same restrictions as in the primary form of the disease. Without being disposed, then, to discard mercury altogether, I am satisfied, from ample experience, that its use may very properly be limited to an exceedingly narrow circle of cases of secondary syphilis, and that, whenever it is rendered necessary, its action will be greatly promoted by the previous employment of tartar emetic. Calomel is, according to my experience, the best form in which it can be exhibited; the dose should vary from the fourth to half a grain, repeated twice or thrice in the twenty-four hours, properly guarded with opium, and carefully watched. Bichloride may be used when the system has been seriously damaged by intemperance and other debilitating influences.

With respect to the topical treatment, in the event of ulceration and discharge, cleanliness is of paramount importance, and is best effected by frequent ablutions with simple water or slightly medicated fluids, care being taken that they do not fret or irritate the skin. Cataplasms and warm-water dressings are among the more soothing local remedies. Various lotions are of service, as weak yellow-wash, and solutions of nitrate of silver, sulphate of copper, tannic acid, and glycerine. When the ulcers are obstinate, mercurial fumigations may be advantageously used. Ecthymatous pustules should be opened, and, after their contents are discharged, the cavity should be gently stimulated with acid nitrate of mercury or solid nitrate of silver. When a papular eruption is seated upon exposed parts, as the face and hands, its disappearance may be hastened by the local application of a weak ointment of ammoniated mercury, or the five-per-cent. oleate of mercury.

3. ALOPECIA.

During the progress of syphilis the hair of the scalp occasionally falls off, generally within the first six, eight, or ten weeks from the appearance of the primary sore, with which, consequently, it is not unfrequently coincident. The affection, which is known as alopecia, usually occurs in circular disks, of variable size, and of a well-marked copper color. It is commonly partial, showing itself in distinct patches, of which several may exist simultaneously, or as fast as one gets well another may succeed, and thus the malady may proceed until it has travelled over the greater portion of the scalp; or, instead of this, nearly all the bulbs may suffer at once, and the hair drop off in great numbers, leaving the head ultimately nearly completely bare. When the system is saturated with the specific virus, not only the hair of the scalp, but also the beard, the eyebrows, and the hair of the rest of the body may disappear. Two well-marked cases of this universal alopecia, both in young men who had suffered from indurated chancre upon the head of the penis, have fallen under my observation. In one the desquamation was associated with roseola and sore throat, and was never followed by a reproduction of hair anywhere; the patient, after having lingered for several years under the exhausting effects of rupia and nodes, died in a state of marasmus. In the second case, the alopecia

was succeeded by syphilitic sarcocele, and the hair was eventually regenerated upon the scalp, although it remained always stunted, and was remarkably coarse, stiff, and sparse.

The first sign of baldness is usually a loss of the soft and glossy state of the hair, which becomes dry, stiff, and brittle, breaking off very readily under the use of the comb. After a little while it is observed to fall off in great abundance; and the scalp is not only remarkably harsh and scurfy, but covered with muddy, dingy, or dusky, copper-colored blotches, generally of a circular shape, and apparently, although not in reality, somewhat elevated above the adjoining surface. Fever occasionally accompanies the affection; and pains in the bones and joints, seemingly of a rheumatic nature, ordinarily characterize the progress of the case. Regeneration of the hair, partial or complete, may generally be expected, even under apparently the most adverse circumstances.

Baldness, as an effect of syphilis, is a grave occurrence, and should, if possible, be promptly arrested. The first thing to be done is to cut off the hair, not closely, but sufficiently to admit of the requisite attention to cleanliness and medication. Shaving of the scalp is seldom necessary. The treatment, directed more especially to the relief of the diseased hair bulbs, must be essentially of a stimulating character, as the object is to impart tone and vigor to the whole of the affected surface. In the more simple cases mild lotions of alcohol and spirit of hartshorn, eau de Cologne and compound spirit of lavender, or alcohol, glycerine, and tincture of cantharides, either in equal, or in different proportions, may be advantageously used. Another excellent wash is a solution of tannic acid and sulphate of copper in equal parts of bay-rum and water, six grains of the former, and half a grain of the latter being added to the ounce of fluid. The application should be made twice in the twenty-four hours, the friction being performed with the hand and fingers, and steadily continued until there is a glow upon the surface. The scalp should be washed every morning with warm water and Castile soap, and well combed immediately after to promote cleanliness and the dislodgment of dandriff.

If soreness of the scalp exist, or if there be eruptions, papules, tubercles, or numerous dry and adherent scales, the most eligible application is a pomade made of ointment of nitrate of mercury, diluted with from seven to ten parts of simple cerate, mixed with a few drops of oil of jasmine and a little Cologne water, and thoroughly rubbed into the roots of the hair night and morning. Along with these means special attention should be paid to the state of the system, and, if the case threaten to be obstinate, or if the alopecia coexist with an indurated, indolent, or badly-healed chancre the patient should be brought as promptly as possible under the gentle influence of mercury.

4. LYMPHATIC ADENITIS.

The posterior cervical glands generally suffer at an early period of the constitutional involvement, becoming enlarged and somewhat tender, although never very painful, and rolling, when pressed with the finger, like so many little elastic balls under the integument. The swelling is generally most conspicuous in the glands along the upper two-thirds of the posterior border of the sterno-cleido-mastoid muscle, and along the root of the hairy scalp, extending frequently as far outwards as the mastoid process on each side. It is essentially of a chronic nature, often lingering for many weeks, and never terminating in suppuration. Diagnostically considered, this species of adenitis, from the constancy of its presence, is of great value, but from the want of practical tact to detect it, it is extremely liable to be overlooked. The number of glands involved seldom exceeds two or three, and in many cases the disease is apparently limited to a single one. Its occurrence is most common in young subjects, and it occasionally manifests itself at so late a period of the disease that it may then be considered as belonging to the tertiary rather than to the secondary order of symptoms.

In syphilis of the lips, tongue, chin, throat, palate, and tonsils, there is not unfrequently an enlarged and engorged condition of the glands at the base and angle of the jaw; and a similar affection of the gland of the arm immediately above the internal condyle of the humerus, between the biceps and triceps muscles is occasionally met with. Marked disease of the axillary glands, as an effect of constitutional syphilis, is very uncommon.

Syphilitic adenitis generally disappears under the treatment directed for the relief of other secondary affections. The enlarged glands may be rubbed twice a day with mild mercurial ointment or ammoniated liniment, or painted with dilute tincture of iodine. If much induration exist, the most eligible remedy will be gentle mercurial inunction.

5. AFFECTIONS OF THE MUCOUS MEMBRANES.

Secondary syphilis of the mucous membranes generally declares itself within a short time after the cure of the primary sore, and sometimes even before this has completely disappeared; existing at one time in association with secondary affections of the skin, and at another, and perhaps more commonly, independently of them. From four to eight weeks is the average period of the evolution of the disease when it attacks these structures. What is very remarkable is the extent of surface over which it may spread, there being no visible portion of the mucous membranes upon which it has not been observed. The parts, however, which are most prone to suffer are the tonsils, palate, pharynx, tongue, cheeks, and lips. It rarely extends into the windpipe. No dissections of a satisfactory nature have been made tending to show that the lining of the stomach and bowels ever participates in the morbid action, but it is certain that well-marked signs of the malady have been repeatedly witnessed at the anus, and in the lower part of the rectum within the first inch or inch and a half of that tube. In the male secondary phenomena sometimes appear upon the foreskin and head of the penis, while in the other sex they are liable to occur upon the vulva, vagina, and uterus. Their presence has not been detected in the respiratory and urinary organs, and is, therefore, altogether a matter of conjecture, to be settled by future observation. From the remarkable relations existing between the skin and mucous membranes, and the fact that syphilitic affections of the former are liable to occur in all parts of its extent, it is not improbable that the latter may suffer in a similar manner, although perhaps not in an equal degree, some portions almost entirely escaping, while others are peculiarly prone to receive and harbor the specific virus.

Secondary affections of the mucous tissue occur in various forms; at one time, or in one place, as an erythematous disease, at another as an elevation or tubercle, and, again, as a distinct ulcer, crack, or fissure; depending, doubtless, upon some peculiar modification of the structure of the suffering part, some change in the action of the poison, or some idiosyncrasy of the individual. In the mouth and throat, where these affections are most common, it is not unusual to notice their coexistence, mere inflammatory redness with or without plastic deposit going on at one point, ulceration at another, and the formation of a tubercle or mucous patch at a third.

Syphilitic *erythema* is observed chiefly in the throat, affecting the arches of the palate, tonsils, uvula, pharynx, and perhaps the root of the tongue. In rare cases it extends to the roof of the mouth. It may present itself as a diffused inflammation, or in the form of distinct patches, generally of a circular or oval figure, from the size of a gold dollar to that of a twenty-five cent piece, the intervening surface being apparently quite healthy. The color, in the early stage of the disease, resembles that of a new copper coin, but it gradually loses its bright, fiery hue, shading off into dark bronze, as the morbid action declines. In cases of long standing and unusual severity, the discoloration is of a deep flesh-color and conjoined with marked thickening of the mucous membrane, along with a tendency to ulceration. Deposits of lymph are not uncommon upon the inflamed surface, even when the disease is not at all active; occurring in small aphthous-looking specks, in patches of considerable size, or in circular rings, more or less firmly adherent, and of a pale orange tint.

This affection which bears the closest resemblance to erythema of the skin, generally exists without the consciousness of the patient, as there is no soreness of the throat, difficulty of deglutition, or constitutional disturbance. All is quiet and passive, the discovery of the disease being perhaps purely accidental. . It of course denotes only a very slight taint of the system. It is liable to appear within the first four or five weeks after the primary sore, and, consequently, not unfrequently before this is healed.

Ulcers of the throat assume various appearances, and involve different structures, but more particularly the uvula and tonsils, arches of the palate and back of the pharynx, affecting these parts either separately or conjointly. They occur principally in two varieties of form, the superficial and excavated.

The superficial ulcer is frequently multiple, several occurring together, either in close proximity, or scattered over the inflamed surface. Its appearance is either that of an erosion, or of a cavity with well-defined, ragged edges, rather sharp, and often somewhat undermined: its surface is covered with a white, yellowish, or greenish, tenacious and adherent lymph: the parts around, although red and irritated, are free from induration. The most common sites of this variety of sore, which now and then assumes a serpiginous character, are the arches of the palate, uvula, and pharynx. It generally comes on early after the appearance of the primary sore, and often coexists with it.

The excavated ulcer looks, as the name denotes, as if it had been made with a punch, or dug out of the tissues with a sharp instrument. Its edges are steep, everted, or ragged, like those of the Hunterian chancre, and they are surrounded by a hard, inflammatory, copper-colored base. The surface is usually encrusted with a greenish, muddy, or yellow-ish lymph, which gives it a foul, unhealthy aspect. The discharge is thin and ichorous. The excavated sore is always most distinctly marked on the tonsils, where it sometimes acquires an immense size, and is generally accompanied by extensive inflammation of the surrounding parts. It is often seen during the progress of the primary disease, and is liable to be associated with some of the earlier forms of cutaneous eruptions, particularly the exanthematous and scaly.

Secondary syphilitic ulcers of the throat are liable to phagedenic and gangrenous action, in the same manner as primary sores, and apparently from similar causes, the state of the system and mode of life of the patient mainly contributing to change their character. From the superaddition of this action, extensive destruction of the soft palate may result, followed by difficulty of deglutition and important alterations of the voice. Ordinary syphilitic ulceration of the throat, even when considerable, is not always attended by well-marked local and constitutional symptoms; the disease, in fact, is often remarkably insidi-ous in its approaches, and may, therefore, have made great progress before its presence is even suspected. The excavated form of the affection is generally accompanied with extensive swelling, pain, and difficulty in swallowing, enlargement of the cervical lym-phatic glands, and more or less febrile disturbance. When the tonsils are the seat of the lesion the tumefaction may be so great as to cause serious obstruction to respiration.

Small ulcers, crevices, and fissures, of a secondary nature, are sometimes met with on the lips, especially at the corners of the mouth, the insides of the cheeks, and on the tongue; generally superficial, indisposed to spread, and attended with but little uneasi-ness and discharge. Occasionally they have abrupt edges and a hardened base. Their diagnosis must necessarily be difficult, the only reliable sign being their coexistence with other marks of syphilis, either primary or secondary.

Mucous *tubercles* occur most commonly upon the tongue, lips, inside of the cheek, ton-sils and palate, as slight elevations of the mucous surface, generally of an irregular oval or elongated shape, and of a whitish hue, as if the secretion of the part had been discolored with nitrate of silver or partially coagulated albumen. Upon taking hold of them with the thumb and finger they are found to be more or less hard, not unlike indurated chancres, and remarkably tolerant of manipulation, even firm pressure rarely causing any decided pain. The size of the spots is variable, ranging from a pea up to that of a twenty-five cent piece; they sometimes exist in considerable number, and then they occasionally become confluent. If unrestrained, they may give rise to ulceration, either superficial, or of a deep, excavated character, with steep, callous edges.

This variety of syphilitic affection finds its analogy in the condylomatous excrescences which are so liable to form about the anus, perineum, and vulva, from the action of the syphilitic virus. As it usually comes on without any pain, its discovery is often purely accidental. The most reliable diagnostics are the peculiar color and feel of the affected part above referred to, and the coexistence of syphilis in other localities, particularly the throat and skin. Not unfrequently traces of the primary disease will be found either in an open sore, or in the indurated cicatrice of a recently healed chancre.

In the female mucous tubercles are frequently met with on the inner surface of the labia and nymphæ, the vagina and uterus, forming whitish, grayish, or opaline spots, of an elongated, ovoidal shape, coming on soon after the appearance of the initial sore, and often terminating in ulceration, sometimes superficial, at other times deep. Fully one-half of the women who suffer from constitutional syphilis are affected with mucous tuber-cles of the genital organs. Patches of this kind are occasionally found between the toes, behind the ears, on the perineum, on the scrotum, and, above all, around the anus. Of 130 cases of this disease in men, reported by Bassereau, 110 occurred in this situation. In women it is most common on the vulva. The infectious character of these bodies has been clearly established by experiments and clinical observation.

Treatment.—These mucous affections being all of a kindred character, their treatment must be conducted upon the same general principles. If the patient be at all plethoric, antiphlogistics will probably be necessary, blood being taken either by the lancet or by leeches from the vicinity of the inflamed parts, and the depletion followed by active purgation and the use of antimonial and saline preparations, rendered anodyne and dia-phoretic by the addition, to each dose, of a small quantity of morphia. Light diet and

perfect quietude are enjoyed. In the milder cases of these diseases the most simple constitutional means will generally suffice, no drain upon the system of any kind being necessary.

The most suitable local remedies are nitrate of silver in substance, or acid nitrate of mercury, variously diluted, and applied at longer or shorter intervals, according to the exigencies of each particular case. The first of these articles generally answers best in my hands when there is no breach of continuity, the affected surface being carefully touched once every forty-eight hours, some mildly astringent gargle, or simple mucilaginous fluid, being employed in the intervals. When the part is ulcerated the caustic must be used more boldly, as well as oftener; although, under such circumstances, I usually give a decided preference to the acid nitrate of mercury, diluted with eight or ten times its bulk of water, and applied very gently by means of a large camel-hair pencil, or a very soft linen mop. Not only the sore, but also the inflamed surface around, should be treated in this way, regularly every twenty-four hours, until there is a decided improvement in the disease. Hardly any secondary ulcer of the throat, or tongue, can withstand such a remedy beyond six or eight days, while in many cases it yields in a much shorter time. As soon as the reparative process begins, the acid is used less frequently and in a much more diluted state. When the acid nitrate of mercury is not accessible, a good substitute will be found in nitric, carbolic, or hydrochloric acid. Sulphurous acid, one drachm to the ounce of water, used in the form of a spray, is also a valuable local application.

The gargle which I usually prefer in ulcerated sore throat is a mixture of pyroligneous acid and water, from one to two drachms of the former to half a pint of the latter, well sweetened with honey, and used five or six times in the twenty-four hours. Weak solutions of subacetate of copper and tannic acid, of tannic acid and glycerine, of nitric acid, and of chlorinated sodium also answer an excellent purpose.

Mucous tubercles generally yield to a few applications of solid nitrate of silver, aided by astringent gargles, suitable purgation and light diet. Similar means usually suffice for the cure of superficial abrasions, excoriations, and fissures of the lips, cheek, anus, vagina and anus.

Mercurialization is necessary only in particular cases. The remedy is generally called for when there is an excavated ulcer, or an ulcer possessing an extraordinary degree of indolence, or indolence and induration. The simple, superficial sore rarely requires such a remedy; and it is of course withheld when there is a tendency to phagedena or gangrene in a broken, anemic state of the system. Under such circumstances tonics, a generous diet, and nutritious drinks, with change of air, take the place of mineral.

SECT. IV.—TERTIARY SYPHILIS.

1. GENERAL CONSIDERATIONS.

When the specific poison has deeply penetrated the system, and is, as it were, inlaid in its different structures, as well as thoroughly commingled with the blood, the effects which it produces constitute what is denominated tertiary syphilis. The boundary line, however, between the secondary and tertiary groups of phenomena is not always well defined, the former affections often running, by gradual and insensible gradations, into the latter; an occurrence which cannot be too strongly weighed, on account of its great practical importance. It is generally understood that those symptoms of the disease which show themselves before the fifth or sixth month from the commencement of the primary sore should be classed under the head of "secondary syphilis," while those which come on subsequently, or after this period, are considered as appertaining to the third order of phenomena, or "tertiary syphilis," the average period of their evolution ranging from six to eighteen months, although in very many instances they do not occur until a number of years after the appearance of chancre, or chancre and bubo. Thus, I have repeatedly seen tertiary symptoms manifest themselves, for the first time, from twelve to eighteen years after the primary disease, the poison having lain all this time, like a hidden spark, in the economy. In one of my cases as many as forty years had elapsed from the primary inoculation. Once fairly roused, however, into activity, it rapidly extends through the system, completely overwhelming it in its progress, and exploding, with peculiar force, upon certain tissues, textures, or organs, as if it possessed a kind of elective affinity for them.

A fourth order of symptoms—the quartenary—has of late been recognized by certain syphilographers, consisting of certain morbid changes caused by disease of the viscera, as the brain, heart, lungs, and liver, and coming on long after the initial sore. The dis-

tinction, however, is not well founded, inasmuch as this tardy appearance is not peculiar to the viscera, but common to them and other structures, particularly the skin, bones, cartilages, and fibrous membranes.

The textures most prone to suffer in tertiary syphilis are the connective tissue, mucous membranes, periosteum, bones, fibro-cartilages, aponeuroses, tendons, and testicles. All parts of the economy, however, may be involved in the contamination, and it is extremely probable that, in the worst cases, hardly any entirely escape. The affections of the internal viscera, although alluded to by many of the older syphilographers, have been especially investigated by Virchow, Dittrich, Lebert, Gubler, Wilks, Bristowe, Budd, and Moxon, who have ascertained that the changes in the lungs, brain, heart, liver, and other organs are generally of a very grave character, liable to be followed by the worst results, the more so because their approaches and progress are usually so insidious that even their existence is frequently not suspected during life, to say nothing of the impossibility of arresting them by any known treatment, or combination of remedies. The most common of these internal lesions are gummy tumors, foul, ragged-looking abscesses, with imperfectly elaborated contents, softening and pulpy degeneration, and tubercular deposits. Attention has not yet been sufficiently directed to the alterations of the ovaries of women dead of tertiary syphilis; but from the resemblance which exists between these organs and the testes, both in structure and function, and from the fact that the latter are so often involved in the disease, it is extremely probable that it will be found, as our pathological researches are extended, that they frequently seriously participate in the morbid action. The uterus rarely suffers, and the Fallopian tubes have never been found involved in this disease.

The gummy tumor, so common in the more advanced stages of syphilis in the internal viscera, as well as in some other parts of the body, is worthy of special attention, particularly in relation to the progressive changes effected in the inflammatory deposits and in the structures at the seat of the morbid action. The earliest noticeable alteration which it experiences is hyperplasia of the interstitial connective tissue, the cells of which increase in size and number; the new substance next becomes soft and gelatinous, melting down as it were; unhealthy pus is thrown out, and, finally, ulceration sets in. In a second form of the deposit, there is no unusual development of the connective tissue; the cells retain their normal features or they assume the rounded shape of granulation cells, and by degrees undergo fatty degeneration, the original mass being eventually transformed into yellow tubercles, so characteristic of syphilis in deep seated organs.

A section of a recent gummy tumor exhibits under the microscope three distinct zones, the outer of which consists of highly vascular granulation tissue; the second is composed of fibrillated connective tissue; the third, of a yellowish color and firm consistence, is constituted by a mass of cells undergoing fatty transformation. The gummy tumor is sometimes known as the fibronucleated tumor, in reference to its peculiar structure. The term fibroplastic is also applied to it. Its essential features are alike in the different organs and tissues.

Tertiary syphilis is not invariably preceded by secondary symptoms; on the contrary, there are many cases where the disease passes directly from the first to the third order of phenomena, the structures usually implicated in the secondary attack escaping entirely. It is well known, too, that tertiary syphilis is not always preceded by bubo, or appreciable induration of the glands of the groin.

Tertiary symptoms are most liable to occur in persons of intemperate habits, and of a dilapidated constitution, with an impoverished state of the blood. A scrofulous or scorbutic condition of the system also acts as a predisposing cause.

The immediate development of tertiary syphilis is often remarkably influenced by the habits and state of health of the individual. It is impossible to say how long the specific virus might lie dormant in the system if the subject of it were entirely free from the prejudicial influences of surrounding agents. Exposure to cold is usually accused as being one of the most common exciting causes of the complaint, and yet it is notorious that the inhabitants of the South Sea Islands and other tropical regions are extraordinarily prone to all kinds of constitutional syphilis. There can be no doubt, however, that the poison is often fanned into activity by the hardships of our northern winters and by a residence in damp cellars, or moist, ill-ventilated, underground apartments, especially when this mode of life is conjoined with all kinds of dissipation and intemperance, loss of sleep, and an impoverished diet. Although it is extremely probable that no state of the system, however nearly it may approach to the normal standard, can ever entirely prevent the

development of tertiary syphilis, when once the poison has taken full possession of it, yet there can be no doubt that an individual so circumstanced will, other things being equal, be much less likely to suffer than one who is differently situated, or who gives himself up to the unbridled indulgences of his passions.

It is an interesting fact, a fact now generally accepted by syphilographers, that the matter furnished by ulcers, abscesses, and suppurating surfaces, during the progress of tertiary syphilis, is not heteroinoculable, or, in other words, communicable from one person to another. Any doubts that formerly existed upon this subject have been completely dispelled by recent observations. That the matter, however, is autoinoculable is an equally well attested fact. I have myself seen two cases which unerringly point in this direction, and testimony of a similar nature has been repeatedly furnished by other observers. In one of these cases—that of a man, upwards of sixty years of age, long the subject of tertiary syphilis—matter taken from an intractable ulcer of the skin of one thigh, and inserted into the skin of the other, produced, in a short time, all the characteristic features of a syphilitic chancre, which, in its turn, yielded inoculable fluid, and was a long time in healing. The other instance was equally remarkable. A gentleman, forty years of age, in 1851, had a chancre upon the penis, which was cured at the end of five months, leaving merely an indurated cicatrice. In August, 1862, without there having been any constitutional symptoms in the interval, an abscess formed in the left groin, and at length opened spontaneously. The sore not only never closed, but extended in a serpiginous manner round the thigh towards the anus. In April, 1867, his medical attendant inoculated the sound limb with the secretions of this sore, with the effect of a formation of a pustule, which gradually degenerated into a large ulcer, with hard, elevated edges, very painful, and for a number of years utterly indisposed to heal.

It is believed that tertiary syphilis is rarely hereditarily transmissible; but although this may be true in the ordinary sense of the term, it is extremely probable that the offspring of such an individual are, if not actually imperfectly developed, naturally predisposed to various kinds of cachectic affections, particularly scrofula, scurvy, and rickets, by which life is rendered miserable and often cut off prematurely, the constitution being unable to endure the hardships incident to ordinary pursuits.

The *diagnosis* of tertiary syphilis hardly admits of general description. Every case must stand, as it were, for itself. Very frequently one of the first evidences of the disease is the existence of nocturnal pains, a node upon the tibia, a gummy tumor in the subcutaneous connective tissue, an eruption upon the skin, an ulcer in the throat, a fetid discharge from the nose, or an enlarged and indurated condition of the testicle. Most commonly, however, the patient is conscious of declining health; his appetite and strength sensibly fail; the secretions are disordered; the countenance is pallid; the spirits are dejected; and there is occasional febrile disturbance. After these symptoms have continued for an indefinite period, various local affections appear, generally so well marked as to render it impossible to mistake their character. The history of the case will also commonly furnish important light; and in some instances the diagnosis is readily determined by the nature of our remedies, especially the use of the iodides, which, when the malady is syphilitic, never fail to afford prompt relief of the more severe suffering.

The *prognosis* of tertiary syphilis is always grave. Whatever form it may assume, it is extremely difficult to dislodge it effectually from the system, or to effect a radical cure. Relapses are of constant occurrence from the most trivial exposure, or the least disorder of the digestive organs, and few patients, however skilfully they may have been treated, are afterwards ever entirely free from rheumatoid pains, proneness to cold, and stiffness of the joints. In fact, although recovery undoubtedly does occasionally take place, yet in most cases the constitution remains in an enfeebled and crippled condition, remarkably predisposed to attacks of other diseases.

Tertiary syphilis often proves fatal, although not nearly as frequently as prior to the discovery of the use of the iodides, death generally occurring from local irritation and constitutional exhaustion. Many of those who recover are horribly disfigured by pock marks, the partial or complete destruction of the nose and palate, loss of hair, anchylosis of the joints, and other affections.

2. TERTIARY SYPHILIS OF PARTICULAR ORGANS.

Nervous System.—Syphilis of the brain and spinal cord is more frequent than it was formerly supposed to be. I have myself witnessed a number of well-marked examples of it. It manifests itself in different ways, but the forms in which it most commonly appears

are mental imbecility, epilepsy, paralysis, and muscular twitches. The paralysis is usually of the kind known as paraplegia; sometimes, however, it affects also the superior extremities. I lately had under my care a gentleman, twenty-seven years old, who, in consequence of a chancre contracted three years previously, was suffering from palsy of both legs and of the right arm. In 1876, I prescribed for a lady, aged thirty-two, who was affected with hemiplegia and aphasia, from an attack of syphilis two years before. The paralysis is generally preceded by numbness and various anomalous sensations, but sometimes its advent is sudden and unexpected.

These tertiary affections of the brain and spinal cord seldom come on until several years after the primary sore, and the worst examples that I have seen appeared to have been induced by the joint effects of the syphilitic poison and the inordinate use of mercury, eventuating in a deposit of fibrin, the formation of gummy tumors, or the development of tubercles. Occasionally considerable serous effusions occur.

The cerebral lesions in tertiary syphilis are either direct or indirect, depending, in the former case, upon the presence of gummy tumors or gummy exudations, and in the latter upon obliterative endarteritis, especially of the circle of Willis, and upon caries, necrosis, or exostosis of the cranial bones, more frequently the frontal than any other. Gros and Lancereaux have collected the statistics of 31 autopsies of direct cerebral disease, in 7 of which softening of the brain existed, and in 12 true gummy tumors. The anterior lobes are especially liable to suffer from these lesions. Cicatricial furrows, similar to those observed in syphilis of the liver, are sometimes seen upon the surface of the brain. Among the more remote effects of syphilis of this organ, are epilepsy and neuralgia, both commonly of a very intractable character. Symptoms of hysteria and chorea are also of occasional occurrence.

The diagnosis is in general readily determined by the history of the case, the existence of syphilis in other parts of the body, as nodes, sores, eruptions, papules, or tubercles, and the dilapidated state of the system. In paralysis, the attack is occasionally ushered in by symptoms closely simulating those of cerebral apoplexy; the stupor, however, soon disappears, and the concomitant phenomena are of shorter duration. In every one of my cases, the paralysis was associated with exquisite tenderness of the dorso-lumbar portion of the spine, and a want of power in the sphincter muscles of the anus and bladder. It is a noteworthy fact that most of the cases of hemiplegia occurring in early life are due to a syphilitic taint of the system.

The prognosis of this class of affections is generally very grave. They are always difficult of cure, and not a few of the patients perish from their effects; some suddenly, others gradually, apparently from sheer exhaustion.

Syphilitic affections of individual *nerves*, eventuating in disturbances of the special senses, anæsthesia, hyperæsthesia, analgesia, paralysis, or neuralgia, are by no means infrequent, although they cannot always be readily traced to their true source. They may depend either upon disease of the nerves themselves, as when they are infiltrated with gummy matter, upon lesion of the brain at the roots of these cords, or upon disease, as caries, necrosis, or exostosis, of the openings in the bones through which the nerves pass to reach their destination. In all these conditions it is easy to perceive how effectually the transmission of the nervous fluid might be interfered with, causing either neuralgia or paralysis of the most inveterate, if not incurable, description. Many of the more obscure cases of these affections are referable to these morbid alterations, which are by far most common in the cerebral nerves, although the spinal are by no means exempt from them. The syphilitic character of these lesions may be suspected when they coexist with a syphilitic taint of the system.

Syphilis of the Eye and Ear.—*Iritis* belongs to the more advanced stages of syphilis, being usually associated with papular, tubercular, or pustular eruptions, rupial sores, nodes, and rheumatism of the bones, and ulceration of the throat, palate, and nose. Its coexistence with the papular form of the disease is exceedingly common. Of eleven cases, observed by Dr. F. F. Maury at the Philadelphia Hospital, in 1866, iritis and papules were present in every one. The affection is characterized by a fixed and contracted state of the pupil, which is generally filled with lymph and displaced upward and inward; by the appearance, upon the anterior surface of the iris, of reddish-brown tubercles, or minute yellowish abscesses; and by severe nocturnal pains, situated deep in the eye, forehead, and temple. The disease commonly attacks both organs, either simultaneously or successively, and always rapidly extends to the other structures, as the cornea, choroid, and retina, involving them in its ruinous consequences, few persons recovering without loss of

sight.   As allusion will again be made to this affection, and also to syphilitic keratitis, in the chapter on the eye, no further notice need here be taken of them.

Retinitis as an effect of syphilis is uncommon ; it generally makes its appearance within the first eighteen months after the primary sore, and as it is usually unaccompanied by other constitutional symptoms it is exceedingly liable to be overlooked.   The most prominent phenomena are pain in the eye and temple, indistinctness of vision, and a sluggish condition of the pupil.   The retina is seen to be abnormally vascular, more or less hazy, and dotted with little whitish, yellowish, or reddish points, of a globular outline, and closely resembling the condylomes observable in iritis.   Considerable œdema is often present, and the optic nerve is seldom free from involvement.

Syphilitic *choroiditis* is also infrequent ; it rarely exists by itself, but is usually associated with iritis or retinitis, and is characterized by impairment of sight, more or less pain, and other symptoms denotive of inflammation of the deeper structures of the eye. The pathological changes are variable, but the most prominent are an injected and varicose state of the bloodvessels, plastic deposits, and serous infiltrations.   The vitreous humor, retina, and optic nerve are always involved in the more severe forms of choroiditis. Both choroiditis and retinitis are occasionally met with as inherited affections.

The *eyelids*, especially the upper, not unfrequently suffer in tertiary syphilis.   The disease generally occurs as an indurated ulcer, somewhat of an oval shape, commencing at the tarsal edge, and thence gradually extending to the other structures.   The borders are inflamed and thickened, the conjunctival lining is more or less œdematous, and there is considerable muco-purulent discharge.   The diagnosis is founded upon the history of the case, the rebellious character of the sore, the indurated and enlarged condition of the glands behind the corresponding ear, and the coexistence of syphilitic disease in other parts of the body.   The only ulcer with which it is liable to be confounded is the epithelial ; but from this it is usually readily distinguished by the fact that the latter never heals, whereas the former often undergoes repair at one point while it spreads at another.   The diagnosis is often promptly decided by the use of antisyphilitic remedies.

Syphilis of the *ear* is uncommon.   Patients of a broken constitution and of intemperate habits are most likely to suffer from it.   The disease generally comes on in the form of sudden deafness, attended with aching pain, and evidently consists of inflammation of the tympanal membrane, which, upon inspection, is found to be red and abnormally vascular, and, in time, to become more or less opaque.   If the morbid action be not soon arrested it may eventuate in ulceration, followed by complete destruction of the membrane, and by permanent deafness.   In the worst forms of the disease, the Eustachian tube, the middle ear, and even the petrous portion of the temporal bone become involved.

The diagnosis is usually sufficiently easy, the most reliable points being the coexistence of syphilis in other parts of the body, the comparative slightness of the pain, which is much less than in ordinary myringitis, and the amenability of the disease to specific treatment.   The affection evidently appertains to the earlier tertiary group.

Digestive Organs and Liver.—Tertiary affections of the throat and mouth are by no means uncommon ; they supervene at an indefinite period after chancre, and manifest themselves in characteristic ulcers, which, if permitted to go on, gradually spread to the palate and maxillary bones, which, together with the soft parts, are sometimes destroyed to a most frightful extent, the buccal and nasal cavities being perhaps laid into one immense cavern.   In some of these cases large portions of the alveolar process of the maxillary bone are necrosed, followed by the loss of many of the teeth, and a similar fate may be experienced by the ascending process and ungual bone, thus implicating and endangering the lachrymal sac and its canal.   The nature of the disease is readily ascertained by inspection and by the altered state of the voice and breath.

Tertiary syphilis of the *tongue* generally appears in the form of ulcers, or fissures, the latter of which are sometimes of enormous extent and depth, reaching far into the substance of the organ.   Specific ulcers are usually situated upon the side of the tongue, at or near its middle, and exhibit the characteristic features of venereal sores in other structures, having a deep, excavated form and a foul surface, with marked induration of the base, the parts feeling, on being pinched, like a mass of fibro-cartilage.   Only one such cavity generally exists, and this, when large and irritable, may give rise to a swelling of the lymphatic glands at the base of the jaw.   The history of the case, the foul, excavated character of the sore, and the existence of syphilitic disease in the throat, nose, or other parts of the body, will always distinguish the lesion from other affections.

Mucous tubercles are occasionally met with, and gummy tumors are not uncommon ; they are generally situated near the base of the organ, deep among the muscular fibres,

and usually rapidly disappear under specific treatment. The more superficial sometimes ulcerate, forming foul, ill-conditioned sores, with a tendency to spread in different directions, and often difficult to heal.

The following case, that of a man twenty-eight years of age, a patient at the College Clinic, affords an excellent type of the tertiary form of this disease in this situation. The tongue, which was of the natural length and breadth but much increased in thickness, and excessively hard at the sides, especially the left, was covered with numerous fissures, of varying size and depth, overhung by steep, indurated edges, which at first sight concealed them almost completely from view. The largest groove, which resembled a deep furrow, extended along the centre of the organ, from a short distance in front of the root to within a few lines of the tip, its depth being nearly half an inch. The bottom of each fissure had a clean, smooth appearance; and there was an entire absence of pain and even of soreness under rough manipulation, although the mucous membrane of the tongue generally was somewhat redder than naturally. The starting-point of the disease seemed to have been the throat, which had been inflamed for a long time; the uvula had become elongated, and had been cut off weeks before. The arches of the palate and the tonsils were still a good deal discolored and congested. The tongue had been in its present condition for three months, having resisted various kinds of treatment, without the disease apparently manifesting any tendency to spread. A small, painful node existed on the right tibia, and there was a vesicular eruption with some itching on the face. Under the internal use of iodide of potassium with bichloride of mercury, and the local application, every other day, of solid nitrate of silver, the man rapidly recovered.

Serious disease of the *teeth* sometimes occurs in tertiary syphilis. It generally manifests itself in the form of a black spot, in the upper incisors, upon the anterior surface of the enamel, close to the gum, and gradually extends until the crown separates from the fang. In time, the lower incisors suffer in a similar manner.

Gummy deposits have been found in the *œsophagus*, terminating in a bad form of ulcer; in other cases the syphilitic disease excites stricture of this tube, as I have myself witnessed in three remarkable instances. These affections always come on long after the primary sore. The history of the case is generally the best interpreter of its nature.

Syphilitic ulceration of the *intestines* is an occasional cause of long-continued dysentery, attended with bloody, mucous discharges, more or less pain, and excessive emaciation. The parts most commonly involved are the colon and the small bowel near the ileo-cæcal valve. Syphilitic stricture of the rectum and anus will be described in a future chapter.

The *liver* is, perhaps, more frequently affected in tertiary syphilis than any other organ, the lung not excepted. The most important anatomical alterations are gummy tumors, or gummy and fibrinous infiltrations, and cicatricial furrows, grooves, or scars upon the surface of the organ. The gummy tumors are of variable size and form, and generally most numerous at the periphery of the liver. They usually coexist with evidence of syphilis in other parts of the body, and generally come on at a very remote period, at ten, fifteen, or even twenty years after the primary affection. There are no symptoms by which they can be distinguished during life from the more ordinary diseases of the liver.

Syphilis of the Heart and Respiratory Organs.—The lesions of the heart and large vessels, consequent upon tertiary syphilis, are imperfectly understood. The subject has been studied with much attention by Virchow, and interesting cases have been reported by Ricord, Lebert, Robert, Gubler, and others. The most important anatomical changes, in the earlier stages of the disease, are fibrinous, albuminoid, or fatty infiltration of the muscular fibres of the heart, interspersed with numerous molecular granules; and, in the more advanced periods, gummy deposits either in the substance of the organ or upon its free surface. Whitish, yellowish, or drab-colored spots, the result of inflammatory action, are occasionally seen upon the endocardium and pericardium. Syphilitic disease of the heart is generally associated with similar affections in other parts of the body, especially of the lungs and liver. The specific degeneration has been noticed in various parts of the arterial system, and is now universally regarded as a predisposing cause to aneurism. Disease of the heart will probably eventually be found to be more common in inherited than in ordinary syphilis.

Syphilitic disease of the *nose*, or syphilitic ozena, as it is occasionally called, manifests iteslf in inflammation and ulceration of the pituitary membrane and of the different bones of the nasal fossæ. In the more severe forms of the affection the proper bones of the nose not unfrequently suffer. The morbid action, which is generally associated with marks of a constitutional taint in other situations, usually sets in at a very remote period

after the primary sore, and lingers on obstinately for many years, notwithstanding the best directed efforts to arrest it, until it has caused the most extensive havoc, piece after piece dying and dropping off until every one has disappeared. When the proper nasal bones are involved, the whole organ, bridge, cartilage, and skin may be destroyed. The disease is attended with an abundant fetid and bloody discharge, and the voice has a peculiarly characteristic, muffled twang. The septum often suffers in this form of syphilis, giving way, first, at the cartilaginous structure, and afterwards at the osseous. Openings, of variable size and shape, are thus formed, with sharp, irregular edges, which have a constant tendency to enlarge until the greater portion of the septum is destroyed.

Syphilis of the *larynx* seldom comes on until a long time after the primary sore, and may, therefore, very properly be classed among the tertiary phenomena. Although it may occasionally be simply an extension of disease from the palate, tonsils, or pharynx, it usually occurs as an independent affection, commencing in the larynx, and thence sometimes passing up into the throat. Its coincidence with syphilis in other parts of the body, particularly of the skin, bones, and fibrous membranes, sufficiently stamps its character, and renders it easy of diagnosis.

The relative frequency of the localization of syphilis in the larynx is undetermined. Gerhardt and Roth detected it in this situation in 18 cases out of 56. One-half of the cases occurred in the third decennium of life. The malady appears to be equally common in both sexes, but is very rare in children.

The disease, beginning in inflammation, soon terminates in ulceration, which often continues for months and even years together, the erosive action being at one time stationary, or on the very verge of healing, and at another steadily advancing. Confined originally to the mucous membrane, it at length invades the arytenoid cartilages, the vocal cords, and even some of the muscles of the larynx. Portions of the thyroid cartilage occasionally perish, and a not uncommon occurrence is the partial destruction of the epiglottis. In some of the cases of this disease that have come under my observation, nearly the whole of the epiglottis was eaten away, nothing but a thick, narrow, stump-like remnant being left, as seen in fig. 81, from a preparation in my private collection. The cricoid cartilage rarely participates in the disease.

Fig. 81.

Syphilitic Ulceration of the Larynx.

The ulcers are seldom numerous, unless they are follicular, when the affected surface is occasionally literally studded with them; generally there are not more than one or two, which are then pretty large, both as it respects their depth and superficial area. They are of a circular or oval shape, with indurated edges and a foul bottom, and, in the more severe and protracted cases, they sometimes penetrate very deeply, opening, perhaps, externally. Such an occurrence is most probable when there is extensive destruction of the thyroid cartilage.

Occasionally the mucous membrane, instead of being ulcerated, is covered with granulations, warts, or excrescences, of a red, fleshy color, from the size of a small pin-head to that of a mustard seed, their number varying from half a dozen to fifteen or twenty; they are usually most conspicuous around the vocal cords, and apparently consist in a hypertrophied condition of the mucous crypts which naturally exist in the interior of the vocal tube. Sometimes the disease manifest itself in the form of distinct nodules, gummy tubercles, or condylomatous excrescences with a broad base. In a case which I recently examined, one of the sinuses of the larynx was completely annihilated, while the other was closed up by a fibroid tumor. The patient, a man fifty-three years of age, had not been able to speak above a whisper for several weeks before his death.

The symptoms are generally well marked, particularly when the disease has made considerable progress, or when it presents itself in the form of ulceration. Besides the wan, emaciated, and cachectic appearance of the patient, which is itself almost sufficient to point out the nature of the affection, there is a hoarse, husky characteristic state of the voice, which is gradually reduced to a mere whisper, and eventually completely lost. The larynx feels tender on motion and pressure; deglutition is difficult and painful; and

the slightest vocal exertion is productive of severe suffering. Cough is always present, frequently to a most harassing extent ; and in attempting to swallow fluids the patient is frequently seized with paroxysms of impending suffocation. The expectorated matter is excessively fetid, often bloody, and occasionally mixed with fragments of cartilage, its quantity being frequently very copious. As the disease progresses, the local and constitutional irritation increases ; the emaciation becomes extreme ; the sweats are copious ; and the patient finally dies completely exhausted, the immediate cause of death being, perhaps, inanition, suffocation, or hemorrhage from the sudden giving way of an important artery. The precise seat and extent of the morbid action can only be determined by laryngoscopic inspection.

The prognosis is variable. The milder cases often yield to treatment, whereas the more severe are generally incurable, especially when attended with a dilapidated state of the system. Syphilitic ulcers are always followed by permanent loss of substance, and by radiating cicatrices, hard, dense, and firm, with a disposition to contract and to cause constriction of the tube. In the vocal cords and arytenoid cartilages they invariably lead to irremediable alterations of the voice, not unfrequently amounting to complete aphonia.

Syphilitic involvement of the *lungs* is uncommon. The disease generally occurs in the form of gummy tubercles, either single or grouped, of variable size and shape, of a dirty grayish color, and, in their earlier stages, of a tolerably firm consistence. The tubercles sometimes exist in large numbers, and are then not always easily distinguishable from ordinary scrofulous tubercles. The matter which is formed during their disintegration is of an unhealthy character, and often remarkably fetid and putrilaginous.

The trachea and bronchial tubes are sometimes inflamed, ulcerated, and even seriously strictured in this disease ; the bronchial lymphatic glands are also liable to suffer, and the pleura is occasionally studded with tubercles and covered with sero-purulent effusion.

The diagnosis is deduced from the history of the case, the presence of cough, the gradual decline of the general health, and the existence of syphilis in other parts of the body.

Urinary and Genital Organs.—The precise character of the syphilitic lesions of the urinary organs is still undetermined. In the kidneys, the most common alteration is interstitial inflammation, attended with gummy deposits, fatty degeneration, and atrophy of the uriniferous tubes, followed by induration of the renal tissue, and deep cicatricial depressions upon the surface of these organs. Occasionally there is amyloid degeneration ; and cases are met with in which the kidneys are tumefied, softened, and of a remarkably pale grayish color, interspersed with little yellowish streaks, dots, or points. The suprarenal capsules are sometimes greatly enlarged, and transformed into fatty matter.

The bladder and ureters are occasionally inflamed, and the seat of plastic deposits. When the disease is chronic, it is very liable to pass into suppuration, especially if it be associated with paralysis of the lower extremities. I lately attended a case of this kind in which the quantity of pus and mucus thrown off in the twenty-four hours was absolutely enormous ; the urine was of a very dark color, and contained, in addition to these ingredients, a large amount of albumen. It was free from odor, and for a long time dribbled off involuntarily, owing to the loss of power in the sphincter muscle of the bladder. Renal casts are often present.

Syphilis of the *testicle* is generally one of the remote effects of this disease. The average period, in the numerous cases that have fallen under my notice, was from two to four years ; but frequently the enlargement does not come on until after the lapse of eight, ten, or even twelve years. It is usually associated with syphilis of other parts of the body, particularly the bones, joints, throat, nose, and skin, the last of which is often extensively ulcerated and otherwise disordered.

The disease almost always involves both testicles, either simultaneously or successively, although seldom in an equal degree ; and, as it proceeds, it is sure to extend to the epididymis, the two structures thus forming eventually one inseparable mass. The swelling is characterized by extraordinary weight and hardness, the affected organ resting upon the hand like a heavy, solid body, and requiring constant support to prevent it from causing a sense of dragging. When the disease has reached its maximum, the testicle is often six to ten times the normal bulk. The surface of the tumor is variable, although generally it is rather smooth, or but slightly knobby. The induration is uniform, except when there is, as not unfrequently happens, an accumulation of water in the vaginal tunic, when the corresponding portion may be soft and fluctuating. The spermatic cord usually

participates in the morbid action, being unnaturally hard and thickened, feeling like a whip-cord when pressed between the thumb and finger. When the disease is of long standing, the affected structures lose their normal characters completely, either at particular points, or throughout, the seminiferous substance being replaced by fibrous tissue. In its worst forms gummy deposits occur, which, breaking down and disintegrating, lead to the formation of unhealthy abscesses and fungous growths.

Syphilitic sarcocele is always a remarkably tardy and painless disease. It is only, as a rule, when there is much water in the vaginal tunic, constituting the complication called hydrosarcocele, and causing constant pressure upon the inflamed and degenerating tissues, that the patient will be likely to suffer much, and then chiefly at night and in damp weather. When the swelling is very large, considerable inconvenience is usually experienced from its weight and bulk. The subjects of this form of syphilis are nearly always thin, pale, and anemic, the appetite is greatly impaired, the strength is wasted, and the sleep is interrupted by nocturnal rheumatism. Their whole appearance, in fact, is indicative of a worn-out, miserable state of the system. When both organs are extensively diseased, the individual must necessarily be impotent. A remarkable feature of this form of syphilis is its tendency to recur, perhaps again and again, after being apparently relieved by treatment.

Syphilitic orchitis is always easily distinguishable from common orchitis, first, by the tardy, indolent, and persistent character of the swelling; secondly, by the simultaneous or successive involvement of both organs; thirdly, by the coexistence of syphilitic disease in other parts of the body, especially of nodes, and ulcers of the skin, nose, and throat; fourthly, by the gradual but certain destruction of the textures and functions of the testicle; and, lastly, by a careful consideration of the history of the case, particularly the character of the patient. When there is unusual obscurity, it is well that the surgeon, before resorting to extirpation, should make a faithful trial of antisyphilitic remedies, otherwise he may have occasion to lament his rashness.

The subjoined case, treated at the College Clinic, affords an excellent illustration of the nature, progress, and termination of syphilitic orchitis, with the changes experienced by the affected organ. The man, aged 29, had, on admission, a fungus of the right testicle, which had commenced, four months previously, as a small pustule on the scrotum. Nine years before he had had a chancre and bubo, and was now laboring under syphilitic rheumatism, ulceration of the tibia, and a slight eruption upon the face. The right testicle had been enlarged, hard, and painful for the last three years; the left one was also diseased, but in a less degree. The general health was much impaired. The fungus was about the size of a half dollar, and the seat of a fetid, ichorous, and profuse discharge, as well as of severe suffering, especially at night. As the organ was hopelessly destroyed, I at once removed it. The tubular structure was completely annihilated, a fibrous substance, of a pale yellowish color and dense consistence, occupying its place. At the posterior part of the epididymis was an abscess, about the volume of a small hickory-nut, filled with a tough, yellowish, cheesy-looking matter, bearing a close resemblance to tubercular deposit. The wound soon healed, and under the use of iodide of potassium and bichloride of mercury, aided by a generous diet, the patient rapidly improved in health and spirits. Whenever syphilitic orchitis is of long standing, whether it be accompanied or not by fungus, the tubular substance will generally be found to be irretrievably destroyed.

The seminal vesicles and prostate gland rarely suffer from syphilis. The deferent tubes, on the contrary, participate in the morbid action, for the most part in conjunction with disease of the epididymis and testes, feeling like hard, firm cords under the skin. In the cavernous bodies of the penis gummy nodes sometimes form, commencing as small, painless lumps, nearly always situated in the posterior third of the organ, where, as they increase in volume, they occasion more or less deformity, and may so completely interfere with the circulation of the blood as to render intercourse impracticable.

Tertiary syphilis is sometimes met with in the breast, either in the form of distinct gummy tumors, or as a diffused indurated condition of the entire gland. The ovaries, uterus, and vagina are occasionally affected, but no disease of this kind has, I believe, ever been noticed in the Fallopian tubes.

Skin.—Ulcers of the skin, which may commence as ecthyma, rupia, or softened gummy tumors, are usually among the more remote effects of the tertiary form of the disease, coming on, in most cases, several years after the primary affection. They usually coexist with nodes and rheumatic pains, or with ulcers of the throat, nose, and larynx, or with all these ailments combined, and are nearly always preceded by scaly eruptions, pus-

tules, papules, or tubercles.   Persons of a broken, infirm, and cachectic constitution are their most common subjects, and those in whom they commit the greatest ravages.

Much diversity exists in regard to the situation and character of these cutaneous ulcers. They are most frequently found on the extremities, especially the inferior ; they are also sufficiently common on the forearm and elbow, and on the scalp, forehead, and temple. Their size ranges from a split pea to that of the crown of a hat, their shape being usually circular or oval, although sometimes it is extremely irregular from two adjoining sores being connected or running into each other. The edges are nearly always callous, everted, and more or less ragged ; the surface is excavated, covered with a greenish, pultaceous matter, and exquisitely sensitive ; while the discharge, which is often very profuse, is thin, ichorous, and offensive, frequently excessively so. In other cases the sore is covered with a brownish-black or greenish-black crust, which may be flattened and depressed, or conical and laminated. It is not often that there is anything like a distinct, well-defined areola ; such an occurrence is very rare, but in most instances there is marked inflammation with redness and induration in the parts immediately around. The largest of these ulcers generally occur on the shoulder, side, and buttock, and it is amazing what an immense size they may attain. Numerous small ulcers of this kind occasionally exist in groups, giving the surface a peculiar worm-eaten appearance. In some cases, again, the ulcers have a serpiginous arrangement ; in another class of cases they are, perhaps, very much undermined ; and now and then two large ulcers are connected together by a kind of cutaneous bridge. In fact, there is no end to the diversities of their configuration. Finally, they may be quite superficial, or so deep as to involve the subjacent connective tissue, and even the fasciæ, muscles, tendons, and bones. Rupial ulcers of the skin are admirably illustrated in fig. 82. The diagnosis is unmistakable.

Fig. 82.
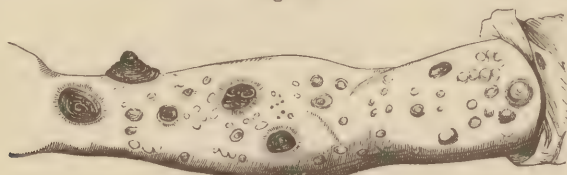
Rupial Ulcers of the Skin.

Syphilitic ulcers often continue for an indefinite period, sometimes partially cicatrizing, now spreading, now indolent, or stationary.   From local causes, as well as constitutional, they may take on almost any kind of action : when the patient is in an exhausted, irritable condition, they are very apt to become severely inflamed, and to assume a phagedenic, sloughing character, often spreading with immense rapidity, both in diameter and in depth. The system generally actively sympathizes with these sores, the skin being hot and dry, the pulse small, quick, and frequent, the appetite impaired, the sleep destroyed, and the loss of flesh and strength excessive. The patient has an old, superannuated, careworn look, with all the signs of a deep-laid syphilitic cachexia. The scars left by the healing of these ulcers are abnormally white, and retain for a long time a remarkable hardness, with a tendency to constant furfuraceous desquamation. They are sometimes very rough, and prone to reopen from the slightest causes.

The diagnosis of a syphilitic ulcer of the skin is generally sufficiently easy, the only affection with which it is liable to be confounded being the common non-specific sore. Its very appearance, in fact, usually at once stamps its character.   In the first place, it is ordinarily circular or oval, and of an excavated shape, with hard, everted edges, and a foul surface, destitute of granulations and of healthy discharge ; the surrounding surface is indurated, and nearly always somewhat of a copper, bronze, or brownish color. Secondly, the sore is often multiple, occurring in groups, and also on different parts of the surface, a circumstance which is generally of itself sufficient to denote its nature ; for the ordinary ulcer is usually solitary, and is most common on the lower extremity. Thirdly, the disease of the skin nearly always coexists with syphilitic disease in other structures, especially of the periosteum and bones. Finally, the effects of the treatment afford important aid in doubtful cases ; ordinary ulcers disappearing, or soon assuming a healthy, granulating condition, under simple antiphlogistics, rest, and light diet, whereas specific ulcers always require the use of the iodides and of mercury, the latter often both internally and externally.

Syphilitic eruptions are sometimes attended with *onychia*, or inflammation of the matrix of the nails, the latter of which gradually become dry and black, and eventually drop off, leaving a foul, excavated, painful ulcer, with hard, steep edges, and a very fetid, ichorous discharge. If the morbid action be very severe, or not soon checked, the matrix will be completely destroyed; most commonly, however, a part of its substance survives, and afterwards makes a feeble effort at the formation of a new nail, generally an ill-shaped, stumpy, horn-like excrescence, wholly different from the original structure. The diagnostic signs of the disease are the copper-colored appearance of the surface immediately around the ulcer, and marks of syphilis in other regions of the body. The lesion occasionally does not appear until many months after the primary sore, thus bringing it, properly speaking, under the head of tertiary symptoms. It is most common in children, as a result of inherited syphilis.

In what is called friable onychia, the nail gradually loses its natural lustre, assumes a dull, yellowish color, becomes thickened at the edges, and readily breaks or cracks, large portions often dropping off on the slightest exposure. The skin under and around the nail is generally much thickened. Hypertrophy of the end of the finger, or even of the entire finger or toe, is a sufficiently common occurrence, especially in inherited syphilis.

Condylomes of the skin, or of the skin and mucous membrane, usually described by the French syphilographers under the name of mucous tubercles, consist of various sized excrescences, of a flat and rather broad appearance, occurring either in groups or as isolated growths, dependent essentially upon a hypertrophied condition of the integument. It is difficult to assign to this disease its precise rank in the order of syphilitic phenomena, or even to affirm, with certainty, that it is always plainly of a syphilitic character. Surgeons of great experience do not hesitate to assert that condylomes may be produced by the contact of gonorrhœal matter, or by acrid vaginal and other non-specific secretions. On the other hand, it has been alleged that they pertain, not to one form of syphilis, but to all three, now following chancre, now secondary syphilis, and now tertiary. As for myself, I am inclined to regard them as belonging rather to the third order of phenomena than to the second, and under no circumstances whatever to the first.

These excrescences are sometimes the result of hereditary syphilis, as I have witnessed in a number of instances. In one remarkable case—that of a lad eight years old—the father had had a similar affection several years previously, in consequence of tertiary syphilis, attended with nodes and scaly eruptions. The tubercles occupied the margin of the anus and the lower part of the perineum, the child being pale and thin, but there was no other evidence of constitutional contamination. The mother had given birth to three infected infants, two before, and the other at the full period; the former were cast off dead, in a putrid condition, and the latter died at the age of three months from marasmus, the whole body having been covered with scaly eruptions, which were particularly conspicuous on the forehead, hands and feet. All the other cases were equally well marked.

The most common sites of condylomes, fig. 83, are the scrotum, perineum, anus, buttocks, and vulva. They also occur, although rarely on the penis, and in the folds of the thigh, in the axilla, and in and around the ear, and between the toes. They have a particular predilection for parts

Fig. 83.

Condylomes.

which are habitually hot and moist; for it is there that they are not only most frequently found, but that they acquire their greatest and most rapid development. Their size and shape are very various. Thus, they may, on the one hand, not be larger than a pin-head, or a mustard seed; while on the other, they often acquire the volume of a filbert, and

even of a small almond. In shape, they are usually flat, with a broad base, although not unfrequently the free portion is much larger than the adherent, a circumstance which gives the growths a pedunculated aspect. When they occur in groups, as is very apt to be the case, they often coalesce, forming thus considerable masses, tuberculated on the surface, irregular in shape, of a reddish color, and of a firm, fibrous consistence. The largest and worst of these tumors always occur at the margin of the anus, and on the perineum, vulva, and other parts which, from the contact of the opposing surfaces, are habitually subjected to friction, heat, and moisture, which, as already stated, are greatly conducive to their development. In these localities, the tumors are always humid, exhaling a thin, muco-purulent fluid, often very abundant, and always excessively fetid. In those parts, on the contrary, where they are more exposed to the air, they are dry, insensible, of a darkish color, and partially incrusted with scabs.

Condylomes often coexist with other evidences of a syphilitic taint, especially nodes, ulcers, tubercles, and scaly eruptions of the skin. Their course is variable ; sometimes steadily onward, at other times stationary, and now and then even retrogressive. Exercise and friction always irritate them, rendering them sore, and more or less sensitive, if not actually painful. When they are large and numerous, the discharge is generally copious, almost insupportably offensive, contagious, and consequently inoculable. They are rarely accompanied by febrile symptoms.

The diagnosis cannot be mistaken. The situation of the excrescences, their peculiar shape, their chronic character, and their fetid secretions all serve to impart to them a distinctive character. Corroborative testimony is often furnished by the history of the case and by the presence of syphilis in other parts of the body.

Connective Tissue, Muscles, and Tendons.—Gummy tumors, of variable size and shape, are liable to form in the subcutaneous connective tissue during the progress of this disease, especially in persons of feeble constitution or broken health. They evidently appertain to the third group of phenomena, are usually very indolent, and seldom, in their earlier stages, encroach upon the skin. In volume they range between that of a pea and a pullet's egg ; they are of a firm, semielastic consistence, and they not unfrequently occur in considerable numbers, several being occasionally seen side by side. Commonly, however, there are not more than three or four, situated perhaps at remote points. In a case under my charge at the Philadelphia Hospital there were two on the chest, one on the clavicle, and one in the hyoid region, the rest of the body being entirely free from them. Perfectly movable at first, they gradually contract adhesions to the surrounding skin, and ultimately suppurate and ulcerate, discharging a thick, gummy matter, whence their name.

Sometimes successive crops of these tumors occur, one disappearing as another arises, and thus the disease is occasionally kept up for months and even years. The resulting abscesses may be very small, and then they are generally proportionately numerous. I have witnessed cases in which hundreds, not larger than a pea, were scattered over the chest, arms, and shoulders.

Gummy tumors occasionally form in the muscles and tendons, generally in connection with syphilitic affections in other parts of the body, as ulcers of the skin or fauces, nodes, exostoses, and tumors of the connective tissue. They range in volume from a pea to that of a pullet's egg, are of a firm, dense consistence, and are seldom attended with severe pain, except when they are breaking down and becoming disintegrated. They are most easily detected by their peculiar feel when the muscles and tendons are relaxed.

The diagnosis of gummy tumors is usually easily determined by their situation, by their semielastic feel, by their coexistence with syphilis in other parts of the body, by their tardy progress, by their tendency to disintegration, and by their history.

Osseous and Fibrous Tissues.—Affections of the periosteum and bones belong to the later order of tertiary syphilis, and they may declare themselves in various forms, of which the most important are nodes, or gummy tumors, inflammatory hypertrophy, exostosis, caries, and necrosis. These affections may come on at any time after the eighteenth month from the date of the initial sore, but in the great majority of cases they do not arise until after the lapse of at least twice that period. They are most liable to occur in persons of a scrofulous and cachectic constitution, and in those whose health has been destroyed by habitual intemperance, constant exposure, and deficient alimentation, leading to an impoverished state of the blood and protracted derangement of the secretions. The idea is now generally prevalent that diseases of the periosteum and bones, especially in their more severe forms, are, in great measure, limited to those persons who have undergone

severe courses of mercury for their cure ; and in this opinion the results of my experience fully concur.   Of the many cases of tertiary syphilis of the osseous tissue which have fallen under my observation nearly all had taken mercury in large quantity, and the few who had been treated without that remedy had suffered comparatively little, except where there was a marked strumous diathesis, which never fails to aggravate the effects of the ingrafted disease.   It would thus appear, at first sight, that this mineral, by combining with the specific poison, was capable of essentially modifying its action, if not of forming a new virus, more potent and destructive than the original.   However this may be, it is certain that the action of mercury, when carried to excess, is a most powerful depressant, the effect of which is felt, for a long time, by the whole system, by the blood not less than by the solids.   A species of physical degradation of the entire organism is thus engendered, which strongly predisposes it to the injurious operation of morbific agents, whether acting within the system, or impressing it from without, through the medium of the cutaneous and mucous surfaces.   Instead, therefore, of supposing that a new poison, or a sort of a syphilitico-mercurial virus, is formed under these circumstances, it will be found to be more in accordance with the established facts of pathology to conclude that the frightful ravages so often committed in tertiary syphilis, after the inordinate use of mercury, in the osseous tissue, are the result, exclusively, of the deteriorating influence of this mineral upon the general system, whereby the more feebly organized structures, as the bones and their investing membrane, are rendered peculiarly prone to the occurrence of a bad form of inflammation, which, if not early checked, often leads to the most disastrous consequences.

Tertiary syphilis is met with only in certain bones, chiefly in the superficial, or in those least protected by soft parts, as the tibia and fibula, ulna, clavicle, and bones of the skull, nose, palate, and upper jaw.   In rare cases, almost every piece of the skeleton is involved, either simultaneously or successively ; some in nodes, some in caries, some in necrosis, and some in exostosis.

Nodes occur principally upon the tibia, the ulna, the clavicle, and the skull, particularly the frontal and parietal bones, as in fig. 84, from Jullien. Apppearing as circumscribed, semisolid swellings, they are of an ovoidal shape, somewhat elastic to the touch, and from half an inch to an inch and a half in diameter.   So far as we are able to determine, they always begin beneath the periosteum, upon the surface of the bone, in the form of a gummy tumor.   The periosteum and bone at the seat of the node, are inflamed, softened, and ulcerated ; and, as the tumor extends, the superincumbent structures, participating in the morbid action, become red and painful, and ultimately yield at the most prominent point, thus allowing the pent-up fluid an opportunity of escaping, although generally in a very imperfect manner, and not without severe suffering.

A node is essentially a broken-down gumma. Its course is always chronic, and the attendant pain is peculiar, being of an intermittent, neuralgic character, subject to violent nocturnal exacerbations.   The general health is usually disordered,
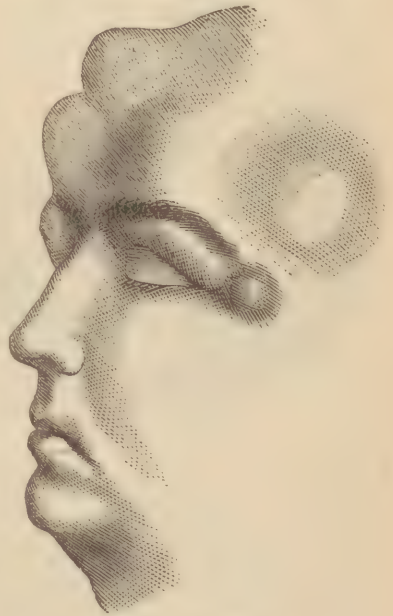
Fig. 84.

Nodes of the Skull.

and, if the swelling is large, there is apt to be considerable constitutional disturbance. Nodes often coexist in different pieces of the skeleton, the skull, for example, being sometimes literally studded with them.

An ulcerated node may take on an almost endless variety of morbid actions, incident to syphilis in other structures.   Thus, it may be excessively irritable, be invaded by phagedena or gangrene, burrow extensively among the surrounding tissues, be complicated with serious disease of the bones, or, lastly, be indolent and indisposed to heal.

Syphilitic *abscess* of the bones is uncommon.   It may occur in almost any portion of the skeleton, and is characterized by long-continued pain, usually deep-seated, circumscribed, and of a dull, heavy, gnawing character, liable to serious aggravation from

exposure, fatigue, or any disorder of the general health. The diagnosis is determined by the history of the case, by the enlargement of the affected bone, and by the peculiar obstinacy of the pain. When the disease is chronic it may persist for an almost indefinite period, as in the case of a man, thirty-three years of age, a patient of mine, who had a deep-seated abscess of this kind in the upper extremity of the tibia for upwards of nine years. In another case the disease had been in progress for sixteen years.

Caries is most common in the long bones of the extremities, as the tibia and ulna, in the skull, and in the palate, maxillary, nasal, turbinated, and ethmoid bones, together with the vomer; it may exist by itself, or be conjoined with *necrosis*, whole pieces often dying and sloughing away, so as to cause the most frightful mutilation and disfigurement. These ravages are generally most conspicuous about the countenance, especially when the disease attacks and destroys the proper bones of the nose, which then cave in, and cause that remarkable flattening of the face so characteristic of the effects of tertiary syphilis. In many cases the turbinated bones, the ethmoid, and vomer are separated, so as to convert the nasal fossæ into one immense cavity; and instances occur where, from the destruction of the palate and maxillary bones, the mouth and nose communicate with each other. In the long bones of the extremities, the caries and necrosis are generally superficial, the dead portions coming away in the form of exfoliations, the central parts of these pieces seldom participating in the morbid action to an extent sufficient to cause their destruction. The sequester in syphilitic necrosis is characterized by its peculiar

Fig. 85.

Syphilitic Caries of the Skull.

porous, cribriform or worm-eaten appearance, dependent upon the peculiar arrangement of the gummy matter that accompanies the process of osteomyelitis. The cicatrice which is left by the healing of the parts is remarkably hard, compact, poorly supplied with vessels, depressed, and of a uniform, whitish appearance.

Virchow has described what he calls "dry caries" of the osseous tissue, as an effect of syphilis; it is most common in the bones of the skull, and is characterized by the entire absence of suppuration, conjoined with rarefaction of the affected part and hypertrophy of the adjacent textures. It may affect both tables of the skull, and, when the depressions accompanying it correspond, it may cause complete perforation.

The adjoining cut, fig. 85, from Druitt, affords a graphic illustration of caries of the bones of the skull, which, as in a case under my observation many years ago, are sometimes so completely riddled as to give them a peculiar cribriform appearance.

Syphilitic *hypertrophy* of the osseous tissue is extremely common, and sometimes involves the greater number of pieces of the skeleton; the bones, however, which are most liable to be attacked are the tibia, fibula, femur, ulna, radius, and cranium. The lesion occurs either as an exostosis, or as a diffused swelling, which, when it affects the whole length and thickness of a bone, assumes the name of general hypertrophy. The mode of formation of a syphilitic exostosis presents nothing peculiar; it evidently takes its rise in a deposit of plasma, which serves as a nidus for the future growth, the ossific process passing through the same phases as in the natural skeleton. The tumor is usually knobby and irregular, with a broad base, and a rough, scabrous surface. In cases of long standing, it is nearly always of a hard, ivory consistence.

The more common variety of hypertrophy is the diffused or general, of which the best specimens are usually seen in the bones of the leg, thigh, and forearm, which are often nearly twice the natural thickness and of extraordinary weight and firmness. A section of such a piece, seen in fig. 86, from a preparation in my cabinet, shows that the spongy substance has been completely, or almost completely, replaced by solid osseous matter, that the medullary canal has been obliterated, and that the compact structure has acquired a closeness of texture almost equal to that of ivory. The Haversian canals are for the most part obliterated, or greatly changed in size and shape, while the outer surface of the bone, as sketched in fig. 87, is remarkable for its roughness, its appearance bearing a

striking resemblance to that of worm-eaten bark. The skulls of persons laboring under tertiary syphilis are sometimes astonishingly hypertrophied. In a specimen presented to

Fig. 86.

General Syphilitic Hypertrophy of the Femur ; Internal Structure.

me by Dr. Cochran, of Louisiana, the cranial bones are throughout at least half an inch in thickness ; the different pieces are completely fused together without any trace of suture or of diploë, and their consistence and density are almost equal to those of ivory.

Fig. 87.

General Syphilitic Hypertrophy ; External Characters.

Syphilitic *osteophytes* occur, both in the long and the flat bones, in various forms ; sometimes as thin, sharp, thorn-like excrescences, and, at other times, as flat, irregular, triangular, or knobby prominences. They are apparently composed of the same material as the bones from which they spring, and often exist in great numbers, especially in the neighborhood of the larger joints.

Extreme *fragility* of the osseous tissue sometimes arises from the effects of the syphilitic poison. A young man, a patient of mine, fractured his humerus, near its middle, in the act of throwing a chip at a person. He was in feeble health at the time, but, under the influence of tonics and iodide of potassium, union occurred within the usual limits.

The *periosteum* is variously affected in syphilitic diseases of the bones ; in the more inflammatory lesions it is generally very vascular, soft, and spongy, at the same time that it is considerably thickened, and easily detached from the subjacent surface. In hypertrophy, especially the diffused form, the principal alterations are thickening and induration, with a tendency, here and there, to ossification. Instead of being easily separated from the affected bone, as it is in the more acute affections, the membrane always adheres to it with extraordinary firmness.

The various syphilitic affections of the bones, but especially diffused hypertrophy, are all attended with more or less disturbance of the general health, and deep-seated, excruciating pains. These pains, from being always worse at night, have earned for themselves the title of *nocturnal*, although they are rarely entirely absent even in the day ; they are also frequently called osteocopic pains, and syphilitic rheumatic pains. They are generally of a dull, heavy, aching, or gnawing character, and begin to increase in severity the moment the patient becomes warm in bed : they may continue all night, or go off in a few hours, but while they last the patient is in great suffering, and is unable to sleep. Not unfrequently they are of a neuralgic nature, excessively keen, darting, and paroxysmal. While they exist, the affected bones are generally exquisitely tender and intolerant of manipulation.

Joints.—A mild form of synovitis is by no means uncommon in tertiary syphilis, especially in persons of a dilapidated constitution, ill-clothed, and ill-fed. The attack generally comes on stealthily, and may last almost for an indefinite period. The joints most liable to suffer are the knees, elbows, and wrists, though hardly any are entirely exempt from it. The accompanying pain is usually of a dull, aching character, and is always aggravated at night and in wet weather. The affected parts feel sore and tender, and are intolerant of the slightest motion and pressure. The synovial membrane generally becomes thickened and incrusted with gummy matter, while its cavity is partially filled with a

turbid, viscid fluid, sometimes spontaneously coagulable. This fluid, which seldom exists in any considerable quantity, occasionally temporarily disappears, and then recurs from the slightest causes, now perhaps more rapidly and abundantly than in the first instance. The structures around the diseased joint are stiff and indurated from plastic deposits, but the integuments are free from disease. The general health is usually more or less deranged.

In the more severe forms of syphilitic synovitis, the disease extends not only to the articular cartilages, but also to the extremities of the bones; the pain and general disturbance are excessive; the swelling and effusion are great; and the morbid action either ends in permanent anchylosis, or in destructive suppuration and ulceration of the joint.

The diagnosis is determined by the history of the case, by the insidious character of the attack, by the peculiarity of the concomitant pain, and by the coexistence of syphilis in other parts of the body.

3. TREATMENT.

The treatment of tertiary syphilis reposes upon broad, scientific, and philosophical principles, and may, therefore, generally be pursued with a positive certainty of affording great relief, if not ultimate eradication. Even the worst cases may usually be immensely benefited in a very short time under the modern system of treatment; and I have repeatedly seen patients, apparently on the verge of the grave, who had not enjoyed a comfortable night's sleep for years, and whose bodies had been sadly deformed and racked by pains, raised to health and usefulness by a few doses of medicine. The remedy to which we are indebted for these wonderful effects is the iodide of potassium, first employed in this class of affections by Dr. Wallace, of Dublin, a remedy, which, if there be such a thing as a specific, is unquestionably entitled to that distinction. Experience has shown that it exercises the same happy influence in tertiary syphilis as quinine in intermittent fever, or arsenic in neuralgia. It is the remedy *par excellence* in tertiary syphilis; a modern discovery of stupendous consequence to the human race; a remedy without which it would be impossible to treat this disease with any prospect whatever of success in almost any case, however simple. Nevertheless, it must not be supposed that iodide of potassium is absolutely infallible; like quinine and other agents, it occasionally disappoints expectation; but we may safely claim for it a degree of certainty which no other article of the materia medica, except, perhaps, iodide of sodium or iodide of ammonium, possesses as an antisyphilitic in the tertiary stage of the affection.

The exhibition of iodide of potassium may usually be commenced without any preliminary treatment; it is only when the patient is anemic, or when there is great disorder of the secretions that any preparation of the system will be necessary, and then it need generally not extend beyond a few days. The proper mode of exhibition is that of solution in distilled water, either alone, or with some bitter infusion or tincture, as hop, gentian, or quassia, such a combination being particularly desirable when a gentle tonic is required. The dose of potassium has been a prolific source of dispute. Long experience has taught me that, while less than eight or ten grains rarely do much good, there are few cases in which more than this quantity is rarely ever needed, repeated three times a day, at intervals of eight hours, the most favorable period for the administration being about one hour after eating. When a rapid effect is required, as when there is unusual urgency of the symptoms, an additional dose may be given, but this will seldom be necessary. I have occasionally exhibited twenty, twenty-five, and even thirty grains at a dose thrice daily, but the effect, instead of being gratifying, has generally disappointed me, the medicine seemingly acting as an irritant rather than as a calmative, as it does when it agrees perfectly with the system. I have never given the article in drachm doses, as it sometimes is by others, and I should regard such practice as altogether unmeaning, if not positively prejudicial. The disease cannot be taken by storm; the treatment must be chronic, in conformity with the course of the malady which it is intended to cure; hence it requires patience, regularity, and perseverance, rather than a display of vigor and heroism. The object should be to accomplish a certain amount of good every day, until the implacable foe is effectually expelled from the system. If the treatment be conducted upon this plan, a most rapid and decided amendment generally occurs; the sleep, appetite, and strength steadily improve; the countenance loses its wan, cachectic appearance; and in less than a fortnight, often indeed in less than a week, the patient looks and acts as if he were a new being, his whole condition, physical and mental, evincing the astonishing change wrought by the medicine.

Iodide of potassium, especially if given in large doses, occasionally signally disagrees

with the system, rendering it necessary either to suspend its use altogether, or to administer it in a modified form, or in smaller quantity. The most common effects of it are an irritable condition of the air-passages, with a sense of fulness in the head and frontal sinuses, a thin, watery discharge from the nose, more or less sneezing, vascular injection of the conjunctiva, and a general feeling of discomfort, the symptoms strongly resembling those of a severe coryza. These effects sometimes declare themselves after the exhibition of a few doses only of the medicine; at other times they do not appear until after the lapse of eight or ten days, or until the system has been pretty well saturated with it. In some cases, depending evidently upon a strong idiosyncrasy, almost the smallest quantity is sufficient to produce excessive discomfort, and an invincible repugnance to the further use of the remedy. Among the more uncommon effects to which the iodide of potassium may give rise are, gastric irritation, diarrhœa, salivation, glossitis, vesicular eruptions of the skin, excessive diuresis, hemorrhagic discharges from the urethra and vagina, and cerebral excitement not unlike that occasioned by alcoholic stimulants.

The best mode of counteracting these disagreeable effects is to combine with each dose of the medicine an anodyne, as a small quantity of morphia, or a few drops of acetated tincture of opium. In some cases I have found the free use of strong hop tea to answer the purpose, while in others a mere diminution of the dose was sufficient. I remember but few instances in which I was compelled, on this account, to abandon the exhibition of the article altogether.

The length of time during which the potassium should be continued must, of course, vary in different cases and under different circumstances. In the great majority of instances it should be exhibited for many weeks and even for a number of months, with an occasional intermission of three or four days, in order to afford the system a short respite, which is always found to be highly beneficial whenever a medicine is employed chronically. An invariable rule with me is to continue the remedy for several weeks after all disease has apparently vanished; and afterwards to give it for eight or ten days at a time at intervals of a month, on the same principle that quinine is administered periodically for the radical cure of intermittent fever.

Iodide of potassium is sometimes advantageously combined with carbonate or muriate of ammonium, the two articles being given in solution, in equal proportions, thrice a day. As a substitute for this article, I often prescribe iodide of sodium or iodide of ammonium. Both preparations are, I am satisfied, fully equal, as antisyphilitics, to the iodide of potassium. During my connection with the Philadelphia Hospital ample opportunity was afforded me of testing their efficacy in numerous instances of tertiary syphilis in all parts of the body; and for the last fifteen years I have rarely employed anything else in private practice for the relief of this disease. The iodide of sodium is preferable to the iodide of ammonium, as the latter is not only offensive to the taste, but liable, unless combined with some corrigent, to nauseate. The average dose of either should not exceed eight or ten grains, and the best time for their administration is from half an hour to an hour after meals. Their action should be aided, when there is much emaciation, by cod-liver oil, iodide of iron, a generous diet, and alcoholic stimulants.

How the iodides act in affording relief in the treatment of tertiary syphilis, whether by neutralizing the poison, or by eliminating it from the system through the emunctories, is still a mooted question. One thing is very certain, and that is, that it passes off largely by the kidneys, generally within a very short time after it is swallowed.

Although iodide of potassium and its kindred articles alone will often rapidly relieve tertiary syphilis, their efficacy is generally very materially enhanced by the addition of a small quantity of *mercury*. Indeed, so thoroughly am I convinced of the decided superiority of this course, that I have for many years almost invariably employed it, thus greatly abridging the treatment, and much more completely eradicating the disease. The plan is particularly beneficial when the affection is of long standing, when it has deeply penetrated the system, as shown by the existence of nodes, nocturnal pains, and ulcers of the skin, and when the patient has been fruitlessly subjected to frequent courses of the iodides alone. An infirm, broken state of the system is no bar to the use of mercury in this mode of combination; on the contrary, it often affords the medicine an opportunity for its best display, especially if it be used along with tincture of chloride of iron.

The form of mercury which I prefer is the bichloride; it is readily dissolved by the potassium, sodium, or ammonium, and may be given in doses varying from the eighth to the sixteenth of a grain, three times a day. The best plan usually is to begin with the tenth of a grain, gradually increasing the quantity if necessary, on account of the obstinacy of the case, to the eighth or sixth of a grain, which should rarely, if ever, be exceeded. The

effects of the remedy are, of course, carefully watched, the slightest tendency to ptyalism being a sign for its suspension, or, at all events, its more guarded use. It will generally be found beneficial to continue the mineral until there is slight tenderness of the gums, with a metallic taste in the mouth, and to keep up this action afterwards for several weeks by repeating the dose occasionally as the effects begin to flag. In short, chronic mercurialization is aimed at, not acute, which never fails to do harm, sometimes immense and irreparable. After the mercurial course has been sufficiently prolonged, the cure may be completed by the use of one of the iodides, now given by itself, perhaps in reduced doses, simply to maintain a slight constitutional impression.

When the bichloride disagrees, which, however, is seldom the case, a good substitute, will be found in the biniodide, which, indeed, sometimes yields better results than the bichloride. The ordinary dose is one-sixteenth of a grain, gradually increased to one-eighth or even one-fourth, thrice a day. The protiodide occasionally answers well, but is more apt to gripe and nauseate. Donovan's solution, a compound of mercury, iodine, and arsenic, is sometimes advantageously exhibited, the dose being from five to eight drops. It often proves serviceable in relieving rheumatic pains and swellings of the bones and periosteum, but it must be given cautiously, as it is very liable to nauseate.

Instead of giving mercury by the mouth, it may sometimes be beneficially administered by the rectum in the form of suppository, consisting of half a drachm of strong mercurial ointment, rendered stiff with a little tallow, and repeated twice or thrice in the twenty-four hours, until the gums are slightly affected, as they often will be in a very few days. The bowels should be well cleared out previously, after which a little morphia should occasionally be exhibited in order to secure the retention of the suppository. This method of treatment is particularly applicable to constitutional syphilis, as it is at once efficient and harmless.

The hypodermic use of bichloride of mercury, in quantities varying from the eighth to the fourth of a grain every twenty-four hours, has been warmly advocated during the last ten years, especially by Max-Van-Moss, Lewin, Kohn, Müller, and Dr. R. W. Taylor. The chief objections to it are that it is inconvenient, that it is liable to produce abscesses and severe salivation, and that patients are often unwilling to submit to it on account of the pain caused by the prick of the syringe, and the contact of the salt with the tissues. To moderate this, the salt should be combined with the eighth or tenth of a grain of morphia. The most eligible points for the injection are the outer sides of the extremities, the chest, shoulders, loins, and nates. Slight ptyalism usually supervenes in a few days. With a view of overcoming its irritating effects, the remedy may be combined with peptone, by rubbing together one drachm of the bichloride, two drachms of chloride of sodium, and one drachm of peptone, dissolving the product in the smallest possible quantity of water, filtering the solution, and evaporating it in vacuo. When perfectly dry, the mercuric peptone is again reduced to powder, and one drachm to three ounces of distilled water forms a one-per-cent. solution of the corrosive sublimate, of which about twelve minims may be used at each injection. The full value of this species of medication remains to be tested.

When the system is much dilapidated, mercurialization is best attained by inunction, fumigation, or the vapor bath, the remedy, when thus introduced, acting often much more beneficially and kindly than when administered by the mouth, which, indeed, it rarely, if ever, should be in such a condition.

The topical application of mercury is particularly to be commended when the syphilitic disease is of unusually long standing; when the surface is covered with irritable, painful, and intractable sores; when there is deep involvement of the bones, as declared by the existence of nodes, diffused swellings, or caries and necrosis; or when the system is greatly exhausted by protracted suffering, want, and exposure, or long and injudicious courses of mercury by the mouth. Thus employed, its effects frequently display themselves in the most striking and efficient manner, in the rapid and extraordinary improvement that follows in the character of the several local affections and the condition of the general system.

The article commonly employed for *inunction* is the mild mercurial ointment, from a drachm to a drachm and a half being rubbed upon the inside of the thighs and arms, once a day, until the constitutional effects of the medicine become apparent by the state of the gums, breath, and saliva. I usually add a small quantity of powdered camphor, with a view of rendering the ointment more soluble, and thereby facilitating its introduction into the skin. The friction should be very thorough, and continued until the ointment has nearly disappeared from the surface. A more cleanly mode of inunction is to

rub the ointment into the soles of the feet, the action of the remedy being greatly promoted by walking. The same stockings should be worn continuously for a week, when the feet are thoroughly washed with hot water and soap, and the frictions are resumed after an intermission of two or three days. The mercurial ointment may be replaced by the twenty-per-cent. oleate of mercury, diluted with an equal quantity of cosmoline.

Mercurial *fumigations* may be conducted in a very cheap and simple manner. All that is necessary is a large comfort, long enough to extend from the floor to the patient's neck, to which it is carefully secured with a piece of tape, to prevent the fumes from escaping into the room and injuriously entering the sufferer's lungs. Or, instead of this, the body may be surrounded with a cloak of oil- or gum-cloth. The patient, completely stripped, is seated in a large arm-chair, or upon a stool, beneath which is placed the fumigating apparatus, consisting of a tin framework with a thin iron plate, and a small spirit

Fig. 88.

lamp, so situated as not to endanger the safety of the person. The most suitable mercurial preparations are the protiodide, bichloride, and biniodide, as they admit of ready volatilization at a comparatively low temperature, and furnish an abundant vapor. The operation, repeated once a day, lasts from ten to twenty minutes, at the end of which the patient is put to bed, well covered, in order to maintain perspiration. Great prostration, however, may follow this sweating process, if it be carried too far, or renewed too frequently. The duration of the treatment must depend upon circumstances, the average period being from two to three weeks.

Mercurial fumigation may sometimes be advantageously combined with steam in the form of the mercurial *vapor-bath*. A very simple mode of applying it is to volatilize the mercury, and to convey the steam by means of a tube from a boiler to the patient's body as he sits in his chair. The most unexceptionable plan, however, is the employment of a tin vessel, with two compartments on the top, one containing a pint of hot water, and the other, the central one,

Maury's Fumigating Apparatus.

the requisite quantity of mercury. The heat is applied with a spirit lamp, the patient being wrapped up in the usual manner. Instead of this contrivance, the more elaborate apparatus represented in fig. 88, and devised by the late Dr. Thomas F. Maury, of Washington, which may be attached by means of a flexible tube to an ordinary gas fixture, may be employed. The best articles are the protiodide, bichloride, and biniodide of mercury, their volatility, as I have ascertained by experiment, being in the order here enumerated. Calomel requires a much higher temperature for volatilization than these preparations, while the red sulphuret, formerly so much employed, is altogether unfit for the purpose. Whatever substance be used, the vapor should be brought as thoroughly as possible in contact with the syphilitic sores.

More or less of the mercury is usually deposited upon the surface of the body, where it must be left to undergo partial absorption. Hence special care must be taken not to wipe the skin. A little vapor, freely diluted with air, may also be inhaled, especially if the principal disease is in the nose and mouth. The operation should be repeated once a day, from ten to twenty minutes at a time, when the patient is put to bed, well covered, to favor gentle perspiration.

When there is much disorder of the secretions, derangement of the alimentary canal, or a feverish state of the system, a short course of preliminary treatment will generally be necessary, as this will greatly augment the efficacy of the fumigation.

Simple and medicated *baths* often prove serviceable in tertiary syphilis, not only as means of cleanliness, but by the direct soothing and healing influence which they exert

upon the part and system. They are particularly beneficial in ulcers of the skin and in rheumatic pains of the bones and joints. An emollient bath, prepared with starch or wheat bran, generally proves most grateful. The common salt-water bath, or a bath containing a small quantity of carbonate of potassium or chlorinated sodium, is an excellent detergent and stimulant in the foul ulcers of the skin and bones so common in the advanced stages of syphilis. Occasionally the water may be advantageously impregnated with bichloride of mercury, from three to ten grains of the salt being added to the gallon of fluid, and the immersion continued for twenty, twenty-five, or thirty minutes. Much caution, however, is required, especially when the surface is considerably denuded, otherwise severe ptyalism may arise. Baths containing nitric, hydrochloric, carbolic, or acetic acid, are sometimes beneficial.

Besides mercury and the other articles above mentioned, there are certain remedies which, although usually considered as being merely auxiliary, are, nevertheless, of great consequence in a curative point of view in the treatment of syphilis. At the head of these may be placed a properly regulated diet, tonics, sudorifics, and anodynes, which deserve the greatest attention in every case of the disease.

It is impossible to insist too strongly upon a well-regulated *diet* in the treatment of this affection, when it is recollected how much its progress and virulence are influenced by the exhausted and impoverished condition of the system which so generally attends it in its more advanced stages. No medicine can possibly produce its full effects under such circumstances, without the aid of good, wholesome, and easily digestible food, stimulating drinks, especially brandy or whiskey, and an abundance of milk and fresh air. The blood must be enriched and the solids rebuilt before it will be possible to neutralize the specific virus, or to eliminate it from the system.

Tonics are nearly always indicated ; and quinine and iron usually answer better than any other combination. The bitter extracts, as gentian and quassia, are generally useless, except in so far as they may tend to improve the appetite. Occasionally benefit accrues from the use of some of the mineral acids, particularly the nitric and phosphoric, largely diluted with water. Formerly, powerful antisyphilitic properties were ascribed to these articles, but it is probable that their good effects are solely due to their tonic virtues, and not to any agency in neutralizing the syphilitic poison. When much emaciation exists, with want of assimilative power, or a feeble digestion, there is no more useful article than cod-liver oil, given in doses suited to the state of the stomach and the general condition of the system.

Sudorifics have long held a high rank in the treatment of syphilitic affections, under a supposition that they aid in eliminating the venereal poison, thus ridding the system of its noxious influence. Whether they possess such property or not, there is no question as to their general usefulness in all states of the economy attended with obstructed perspiration, so often present in the advanced stages of syphilis, particularly when there is serious involvement of the skin. The object for which such medicines are usually prescribed may readily be obtained by the warm, hot, or steam bath, assisted by tepid drinks, and various kinds of diaphoretics, as Dover's powder, antimony and morphia, and similar articles. Some caution is necessary in the use of sudorifics, lest injurious debility be induced.

But of all the auxiliary remedies now described, the most important, in every respect, are *anodynes;* their employment is absolutely indispensable, and it is, therefore, impossible to assign to them too high a rank. They are, up to a certain stage of the treatment, of more consequence even than food and drink. The patient is not only unable to sleep, but his body is literally racked with pain and irritability. To look, under such circumstances, for any substantial improvement from ordinary remedies, would simply be absurd. The first thing to be done is to quiet the system and induce sleep ; and to accomplish this, anodynes must be exhibited in large and sustained doses, a quarter of a grain of morphia, or its equivalent of solid opium, laudanum, or black drop, being given every eight, ten, or twelve hours, according to the effects of the article. The manner in which anodynes are often borne, in the worst forms of tertiary syphilis, is astonishing, and can only be explained by the tolerance established by the irritable condition of the nervous system. When the insomnia depends upon exhaustion, the morphia may generally be advantageously combined with chloral, or chloral may be freely given by itself.

As to *sarsaparilla*, formerly so much vaunted in the treatment of this disease its employment in my hands has never been productive of any appreciable benefit. Whether this has arisen from ill luck, or from the use of an inferior article, it is not in my power to affirm ; I may state, however, that I have exhibited it in every form and mode of

combination in which it is given in this and other countries, and am, therefore, inclined to believe that it has been invested with virtues which do not belong to it, or which are due mainly, if not solely, to its associate ingredients.

Finally, persons laboring under tertiary syphilis should have the benefit of a pure, dry atmosphere, and be well protected from cold by flannel worn next to the skin both summer and winter. When it is remembered how easily the disease is provoked by suppression of the cutaneous perspiration, and by living in damp, underground, and ill-ventilated apartments, the importance of attention to this injunction cannot fail to be fully appreciated.

Sea bathing and a residence at the seaside are often of advantage in syphilitic persons of deteriorated constitution; and the Hot Springs of Arkansas have become a sort of El Dorado for this class of patients, thousands annually flocking to them from different sections of the United States. It is questionable, however, whether the use of these waters is of any real benefit. The good which results from the visits is probably due, in great measure, if not entirely to the change of air, food, and scene, and to the liberal employment of the iodides and of mercury to which this class of patients are invariably subjected by the resident physicians. The use of sulphur water, in the form of drink and baths, has also been greatly extolled, but the praises lavished upon it have never been realized. In France, Germany, and other European countries there are a number of resorts celebrated for their supposed antisyphilitic virtues.

Syphilitic affections of the nervous system must be treated with the iodides in very large doses, experience having shown that the doses administered in syphilis as it occurs in other parts of the body are worse than useless. Not less than twenty, twenty-five, or thirty grains should be given thrice a day an hour and a half after meals, and this quantity should be gradually increased, with an occasional intermission, to the full extent of tolerance of the stomach. The efficacy of the prescription will be materially increased by the addition to each dose of the eighth or tenth of a grain of bichloride of mercury and an occasional large dose of quinine. An issue made with the hot iron when the seat of the disease can be localized, will be found to be a powerful adjuvant. When, from idiosyncrasy, or any other cause, the iodides are inadmissible, our main reliance must be upon mercury, carried, if the system is not too much impaired, to slight but persistent ptyalism.

The treatment of tertiary syphilis of the heart and bloodvessels, the lungs, liver, and spleen, differs in no respect from those just mentioned in connection with the treatment of syphilitic affections of the nervous system. The great point is to push the remedies to the utmost before the gummy or specific matter has undergone the softening process.

In regard to the topical treatment there are certain rules which are applicable to all local affections, whatever their nature, site, or extent. Thus, there can be no hesitation about the removal of dead bone, opening abscesses, tracing out sinuses, dividing fasciæ or aponeuroses, and trimming off the ragged, undermined, and impoverished edges of cutaneous ulcers, so as to place them in a more suitable condition for speedy repair. All this is self-evident, and only requires mention to secure attention. Cleanliness is of paramount importance, as it contributes not merely to personal comfort, but also, in a powerful degree, to recovery. Fetor is allayed by the free use of deodorizers, as chlorinated sodium and permanganate of potassium.

Ulcers, fissures, eruptions, papules, and tubercles of the *skin* often recover under very simple topical treatment, as weak solutions of nitrate of silver, or acid nitrate of mercury, aided by the use of iodide of potassium, or potassium and mercury, with attention to cleanliness and other hygienic observances. When much inflammation is present, with a foul appearance of the part and a tendency to spread, acetate of lead and opium will come in play, with emollient cataplasms, or warm water-dressing, simple or medicated. Touching the sores lightly once a day, or every other day, with dilute acid nitrate of mercury or a weak solution of nitrate of silver, generally singularly promotes the cure. Unguents are not always as bad as they have been represented to be in these cases. I have often employed them with excellent effect, especially opiate cerate, balsam of Peru ointment, and ointment of nitrate of mercury, weakened with six, eight, or ten times its bulk of simple cerate or cosmoline. Mercurial ointment, diluted, and mixed with opium, frequently makes a most useful dressing in the indolent form of rupial ulcer. Sprinkling the surface of the sore with calomel, iodoform, or nitrate of lead, and keeping it covered with dry lint, sometimes rapidly promotes cicatrization.

The bronze and copper-colored stains of the skin which follow certain forms of syphilis are often very unseemly, and, therefore, a source of annoyance to the patient. The best remedies are minute doses of mercury and the frequent use of the sulphur vapor-bath.

Syphilitic *onychia* is, strictly speaking, a rupial ulcer, to be treated in the same manner as similar sores elsewhere. One of the most valuable applications is nitrate of lead, sprinkled upon the sore several times a day, and kept in place with dry lint. Iodoform is also a useful remedy. Unhealthy granulations must be repressed with caustics or the scissors. If abscesses form under the nail, they must be punctured; and if the nail die, it must be removed, or trimmed, especially if it overhang and injuriously compress the diseased structures. Friable onychia demands no special treatment beyond trimming of the nails, and the application of lead water, if the soft parts around are inflamed.

The topical treatment of tertiary ulcers of the *throat*, mouth, and tongue is restricted principally to applications of acid nitrate of mercury and solid nitrate of silver, at first once a day, and subsequently every third or fourth day, according to the condition and progress of the sore. Weak gargles, or washes of acetic acid, tannic acid, and sulphate of copper, chlorinated sodium, or cyanuret of mercury, from ten to sixteen grains of the salt to a pint of some bland, mucilaginous fluid, as linseed tea or infusion of elm bark, may be employed in the intervals.

In the treatment of syphilis of the *nose*, the chief reliance must be upon injections of weak lotions of iodide of iron, sulphate of copper, and tannic acid, tincture of myrrh, permanganate of potassium, and chloride of zinc, particularly the latter, as they impart not only a healthy stimulus to the affected surfaces, but effectually allay fetor, so distressing in this class of complaints. Mercurial preparations are generally improper, from their liability to pass into the stomach, and thus occasion salivation. In using injections for the nose, a large syringe with a long, perforated nozzle is required, to bring the fluid fully in contact with every portion of diseased structure. They should be repeated at least thrice a day, with special care not to distress by their severity. The hydrostatic mode of cleansing and medicating the nose, with Thudichum's apparatus, is now generally, and, indeed, very justly preferred to the more ordinary procedure, as it is far more thorough and effective.

If the affected parts are within reach, regular and steady medication may be effected with lint smeared with some suitable ointment, as glycerine and tannic acid, or wet with some slightly stimulating lotion, as Goulard's extract, nitrate of silver, sulphate of copper, or chlorinated sodium. In all cases the nasal cavities should be frequently inspected, with a view to the early detection and removal of dead bone.

In syphilis of the *larynx* direct medication may be attempted by means of the mop wet with a weak solution—from ten to twenty grains to the ounce—of nitrate of silver, introduced once every third or fourth day, the patient being at the moment partially under the influence of chloroform, so as to render the parts more passive, and, consequently, more tolerant of the operation, which is otherwise very apt to prove abortive. When the disease is extensive or the case urgent, as when there is deep ulceration with excessive difficulty of deglutition, frequent spasm of the muscles, or œdema of the glottis, the only resource is tracheotomy. Direct medication may then be made with acid nitrate of mercury or with any other article that may seem expedient. If warty excrescences exist, they may be clipped off with the scissors, repullulation being prevented by escharotics or sorbefacients. Dead cartilage is removed in the usual way.

The great remedy for syphilitic *iritis* is mercury pushed to rapid but general ptyalism. If the patient is young or plethoric, blood is freely taken from the arm, or by leeches and cups from the temple. Opium is given to allay pain and to restrain the action of the mercury upon the bowels. If, on the other hand, there is evidence of exhaustion, or of an anemic, shattered state of the constitution, stimulants and tonics, as iron and quinine, with a generous diet, and gentle exercise in the open air are at once employed. Mercury is either entirely omitted, or administered very sparingly. In general, the most suitable article, in this condition of the system, is corrosive sublimate in union with iodide of potassium. Turpentine, so strongly recommended by Carmichael and others in such cases, as a substitute for mercury, is seldom of any use, and is certaidly not reliable as a curative agent. In addition to these general measures it is of the first importance to keep the pupil constantly dilated by instillations of four grains of sulphate of atropia to the ounce of distilled water.

Syphilitic ulcers of the *eyelids* generally promptly yield under the influence of iodide of potassium and the application of very dilute citrine ointment.

Syphilis of the *ear* is managed upon the same general principles as syphilis of other organs. The great remedies are mercury and potassium, aided by leeches, blisters, and mildly astringent injections.

The local treatment of affections of the *bones* and periosteum must be strictly anti-phlogistic. The pain and swelling are often immensely benefited by tincture of iodine, leeches, and blisters, although in very many instances they readily yield to the exhibition of iodide of potassium and mercury. A node, as a rule, should not be opened so long as it is very small, and free from serious annoyance; when the reverse is the case, it should be freely incised, and so also if it be the seat of distinct fluctuation, denotive of the exist-ence of matter. A good rule, under such circumstances, is to make the knife graze the bone, imperfect division of the parts being generally worse than useless. If the resulting ulcer is slow in healing, it should be well blistered, or dressed with mercurial ointment, or some stimulating and anodyne lotion. Sometimes the pain and tension of a node may speedily be relieved by subcutaneous incision, effected by means of a delicate bistoury, carried about in different directions and in such a manner as also to divide the periosteum. Necrosed bone must be removed as soon as it is sufficiently loose to admit of easy separa-tion; while carious bone must be scraped and otherwise managed to put it in a suitable condition for repair. Diffused hypertrophy rarely requires any other than constitutional remedies. When the affection is circumscribed or not too widely extended, great and prompt relief sometimes follows the use of the trephine, several small, circular disks being removed by carrying the instrument nearly through the entire thickness of the affected bone. When the disease is caused by an abscess, nothing short of such an operation will be of the slightest benefit. Evacuation must be effected without delay. An exostosis, acting obstructingly, must be removed with the saw or pliers.

The most suitable means in syphilitic *synovitis* are iodide of potassium and mercury internally, and locally acetate of lead and opium, leeches, blisters, and tincure of iodide, with perfect rest of the affected joint.

Syphilitic *sarcocele* is treated, topically, upon the same principles as swelling of the testicle from gonorrhœa; by rest of the body and elevation of the parts, leeches, astringent and anodyne fomentations, and mild mercurial inunctions. When the enlargement is indolent and rebellious, strapping may be employed, either with common adhesive plaster, mercurial and ammoniac plaster, or the plaster of Vigo. The cure is often retarded in these cases by the presence of a considerable quantity of serum in the vaginal tunic, com-pressing and irritating the diseased organ; an effect generally promptly relieved by a free incision, or by numerous punctures. Abscesses are treated in the ordinary manner. Internally free use is made of the iodides.

When the testicle is fungous, ulcerated, and completely disorganized, the only resource is removal, no treatment, either general or local, proving of any service in such a case. Before, however, so serious an operation is ventured upon, it should always be ascertained by exploratory incisions that the organ is really, and not merely apparently, past recovery.

The treatment of *condylomatous* growths must be general and local. Topical applica-tions alone will, it is true, often effect riddance without difficulty; but to cure the disease permanently constitutional medication is usually indispensable. The most efficacious remedy, undoubtedly, is iodide of potassium in union with bichloride of mercury, admin-istered as in ordinary cases of tertiary syphilis, the diet, bowels, and secretions being at the same time suitably regulated. The specific treatment should be prolonged, in a modi-fied manner, for several weeks after all disease has apparently vanished, in order to break up the tendency to recurrence.

In regard to the topical treatment, cleanliness is of primary importance, hardly less on account of the attendants than the patient himself. Free use must be made of tepid water, impregnated with chlorinated sodium, and applied by means of a sponge or syringe, the dressings and the bedclothes being frequently sprinkled with the solution, especially if there be much discharge. Another important element of treatment is perfect rest with isolation of the affected parts, their contents, as previously stated, having a tendency to foster growth and secretion. To repress the tumors, various articles may be used, one of the best of which is chromic acid, brushed on once in the twenty-four hours, until they are shrivelled and dried up, as they generally will be in a few days. A lotion of bichloride of mercury, in the proportion of twenty grains to the ounce of water, is also an excellent remedy. Nitrate of silver, nitric acid, and acid nitrate of mercury, so commonly recom-mended, are all extremely severe, besides being very uncertain. In the intervals of the applications, the excrescences should occasionally be sprinkled with some desiccating sub-stance, as calomel, prepared chalk, or carbonate of zinc, and protected with a large roll of dry lint, retained with a T-bandage. Under this management, the tubercles soon lose their sensibility, and rapidly disappear. Perfect cleanliness must be observed for a long

time after the cure is completed, otherwise relapse may occur. When unusually large and rebellious, the growth is more easily disposed of with the scissors, the hemorrhage, which is often copious, being repressed, if necessary, with Monsel's salt.

SYPHILIS IN THE INFANT.

There are two modes in which infants may become infected with syphilis. First, they may suffer from direct inoculation, and, secondly, the disease may be communicated by either parent; by the father in the act of copulation, or by the mother during the progress of pregnancy. It has also been supposed that a child may be contaminated by the milk of an unsound nurse ; and there are numerous cases upon record, going to show that the poison may be communicated in suckling by a sore or mucous tubercle on the nipple. Direct primary syphilis, however, is most generally contracted during parturition, as the child passes through the soft parts of the mother, from inoculation of the body with the secretions of a chancre of the uterus, vagina, or vulva. The idea that the specific matter may enter the system through a sound surface, by the agency of the absorbent vessels, is untenable.

In whatever manner the infection is communicated, the disease pursues the same course as when it occurs in the adult, whether from sexual intercourse or artificial inoculation. The child may perish from the local irritation, or, if it survive the primary affection, it may afterwards suffer from constitutional syphilis, the impression manifesting itself in cutaneous eruptions, mucous tubercles, sore throat, ulceration of the nose, gummy tumors in different parts of the body, and rheumatic pains in the bones and joints.

In the great majority of cases of infantile syphilis, however, the disease is communicated either through the seminal fluid of the father in the act of procreation, or by the mother through her blood after the ovum has taken up its residence in the uterus. That the contamination may occur in both of these ways is a fact that has long been incontestably established. The semen is a living fluid, and in a man laboring under constitutional syphilis the probability is that every spermatozoon is completely impregnated with the specific poison; hence it is only necessary that it should come in contact with the ovum of the mother in order to produce thorough vitiation of the new being. Thus, the very fountain of life is poisoned in the very act of conception, and it is, therefore, not surprising that all its sources should participate in the evil thus entailed.

The time at which a female with secondary symptoms may communicate the poison to her offspring cannot be accurately stated. The probability is that it is very short. This is proved by the circumstance that such a woman frequently aborts within a few months after conception, evidently from the deleterious effects of the virus upon the fœtus. It is supposed that syphilis may be communicated to the child through the amniotic fluid, but if this be so, the question is still an open one.

It has been alleged that a healthy child, or child born of healthy parents, may be infected by a nurse affected with secondary syphilis; the milk being tainted, and capable of communicating the disease. Of the possibility of such an occurrence I entertain great doubt; my own practice has certainly not afforded me any examples of it, while it has fallen to my lot to see several cases where the converse was the fact, healthy children having sucked infected women, and yet remained perfectly sound.

As an infected mother may communicate syphilis to her child in the womb, so, on the other hand, may a child, contaminated by its father, impart the disease to the mother, although she may herself have been perfectly sound at the moment of conception. The occurrence, however, is by no means constant. Dr. Victor De Mèric, for example, has collected not less than thirteen cases in which the mother gave birth to a syphilitic child, and yet she herself never exhibited any signs of the malady in her own system.

The question, whether an infected infant can communicate the disease to its nurse in the act of suckling, is well settled. The secretion from a mucous tubercle of the tongue, cheek, or lip may thus be brought in immediate contact with the nipple, which it will be almost sure, eventually, to inoculate, especially if it be the seat of any cracks, fissures, ulcers, or abrasions. It has been alleged, with a good deal of plausibility, that a woman affected in this manner may, in turn, infect her own offspring. In a case related by Mr. Hunter, and upon which great stress has usually been laid by authors, it is asserted that the diseased infant thus successively inoculated three wet-nurses, two of whom afterwards conceived, and were delivered of syphilitic children. Although a wet-nurse may contract the disease in this manner, there is not, so far as is at present known, a reliable instance

upon record in which a mother has ever been infected from suckling her own offspring. This apparent anomaly is readily explained by the fact that when the system has once suffered from a taint of this kind, it is not susceptible of a second attack. It proves the unicity of the poison, and shows that, under such circumstances, either both mother and child are equally affected, or that the mother is from some constitutional inaptitude incapable of contracting the disease.

The question whether a husband laboring under secondary syphilis may communicate the disease to his wife through the agency of the semen, unaccompanied by impregnation, is no longer a mooted one. It is absurd to suppose that this fluid, when injected into the vagina and uterus, is ever absorbed, no matter how long it may be retained, so as to make a prejudicial impression upon her system. Of such an occurrence there is certainly no satisfactory proof. It is different when conception occurs. Here, as already seen, the semen mixes directly with the ovum of the female, to which it at once imparts its deleterious properties, thereby effectually tainting the new being in the very act of its creation.

Hereditary syphilis is generally a grave disease; for, unless it is judiciously treated, it nearly always proves fatal. A great majority of the neglected cases terminate in abortion, the fœtus often perishing as early as the end of the third month, and from thence on death may occur at any period up to the full term of gestation, the child being usually thrown off in a putrid and more or less offensive condition.

The immediate cause of abortion in a syphilitic mother is a diseased state of the placenta, commencing, apparently, at an early stage of pregnancy, in inflammation of the decidua, by which its substance is indurated and thickened, followed by obstruction in the maternal circulation, and consequent atrophy and arrest of development of the fœtus. In addition to this there is always a greatly deteriorated state of the mother's blood, rendering it unfit as a source of nourishment. When the disease is communicated by the father, the placenta generally suffers secondarily, the syphilitic affection beginning in the fœtus.

The number of abortions is sometimes remarkable; in one instance, under my own observation, it amounted to thirteen, the woman never having brought forth a healthy infant; and in another there were fifteen abortions and miscarriages, with two healthy births between the seventh and ninth mishaps. Cases of three or four successive accidents of this kind are by no means uncommon. Now and then a woman will abort several times consecutively, and then be delivered of an apparently healthy child; I say apparently healthy, for, although the new being may be perfectly plump and fat, and exhibit all the outward signs of the most perfect integrity, yet generally, in a very few weeks, it will be found to present unmistakable marks of decay and disease. The first thing that is usually noticed in a syphilitic child is that it loses flesh and strength, becoming gradually thin and puling, and looking as if it had been withered by the sudden drying up of its juices. The skin, of a dingy, muddy shrivelled appearance, hangs about in loose, soft folds. The countenance, shrunken, wan, and ghastly, resembles that of a man of seventy-five or eighty, instead of an infant a few weeks old. The voice is husky; the respiration is snuffling; the throat is sore; the gums are red and spongy; the lips and anus are fissured; and the body is covered with copper-colored eruptions, usually of the scaly kind, and intermixed with tubercles. Purulent ophthalmia is not uncommon, the inflammation coming on within two or three days after birth, and generally ending in total blindness. In some cases numerous superficial ulcers are found upon the surface, attended with a thick, tenacious, discharge, and a hard, reddish, characteristic base. The hair often drops off in large quantity, both on the scalp, the eyebrows, and on the rest of the body. The well-developed node and orchitis are of rare occurrence in infantile syphilis. Death, under such circumstances, usually occurs within the first three or four weeks after birth. Occasionally, the patient may reach the end of the second or third year, and in exceptional instances life may even be prolonged until after the period of puberty, the individual having a stunted, sickly growth, accompanied, perhaps, with deep ulcerations of the throat, palate, nose, and skin, disease of the teeth, especially of the upper central incisors, caries of the bones of the extremities, and stiffness of some of the principal joints. Few children recover, and those who do are doomed to drag out a miserable existence, generally amidst the most loathsome and disgusting deformities.

Under proper treatment, especially the judicious use of mercury, the specific virus in a syphilitic woman, may in time, be so completely neutralized as to enable her to bear healthy children. Bumstead thinks that, as a rule, after the lapse of six years, the influence of the disease is so far exhausted as to render the risk of transmission very slight. Such a statement must have many exceptions.

Infantile syphilitic eruptions are liable to be mistaken for some of the more common

affections of the skin incident to early childhood, and the diagnosis is, therefore, not un-frequently environed with great difficulty. In obscure cases, the chief reliance is to be placed upon the history of the attack, and other concomitant circumstances. From three to four weeks after birth is the average period of the appearance of the cutaneous affec-tions, the sole of the foot, the buttock, scrotum, face, chest, and inside of the thigh and arm being the parts originally involved. The surface immediately around the eruptions is of a coppery, reddish-brown, or bronze color, a condition very different from what is observed in ordinary diseases, especially eczema, lichen, prurigo, and lepra, with which they are most liable to be confounded. Besides this, which is always a most important symptom, diagnostically considered, the general appearance of the infant shows that it has received a severe shock; it is thin and emaciated, and progressively fails to an extent and in a manner altogether unusual in common cutaneous maladies. The old, withered, and shrivelled look of the child is, of itself, almost characteristic of the disease; the snuffling is another important element in the discrimination of the case, and too much stress cannot be laid upon the mottled, dingy, or muddy state of the skin. The history of the case will usually show that the parents have been the subjects of syphilis, or that they are actually suffering from its effects.

Much stress is very properly laid upon the condition of the teeth as a diagnostic sign in hereditary infantile syphilis, attention having first been directed to the subject by Mr. Hutchinson, of London. The disease occurs chiefly in connection with, or as a result of, specific stomatitis, and displays itself more particularly in the upper incisors, although the lower incisors and even the canine teeth occasionally participate in the morbid action. The first evidence of the disease generally is a dirty, dingy, or light brownish appearance of the enamel of the central and afterwards of the lateral incisors, which soon begin to soften and crumble away, the child ultimately becoming edentulous. Both sets of teeth are cut prematurely, as well as very irregularly, as it respects their position in the jaw; and, unless the constitutional taint is early eradicated, the permanent are doomed to share the same fate as the temporary, although they are destroyed less rapidly.

Mr. Hutchinson considers the upper central incisors as the test teeth of hereditary syphilis. "When first cut," he remarks, "these teeth are uncommonly short, narrow from side to side at their edges, and very thin. After a while a crescentic portion from their edge breaks away, leaving a broad, shallow, vertical notch, which is permanent for some years, but between twenty and thirty usually becomes obliterated by the premature wearing down of the tooth. The two teeth often converge, and sometimes they stand widely apart. In certain instances, in which the notching is either wholly absent or but slightly marked, there is still a peculiar color, and a narrow squareness of form, which are easily recognized by the practised eye." The characteristic appearances of infantile syphilitic teeth are well illustrated in figs. 89 and 90.

Fig. 89.   Fig. 90.
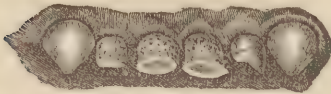
Syphilitic Temporary Teeth.   Syphilitic Permanent Teeth.

The eye also frequently suffers in inherited syphilis, iritis, and corneitis being the affec-tions most commonly met with; they are more frequent in female than in male children, and occur alike in the well-fed and in the half-starved. Iritis seldom appears before the fifth month, and is usually attended with an abundant effusion of lymph, with great danger of occlusion of the pupil. Corneitis is most frequent from the eighth to the fifteenth year, and is almost invariably associated with a dwarfed and notched condition of the perma-nent central incisor teeth of the upper jaw. It generally gives rise to marked opacity of the cornea.

Deafness is a not infrequent result of inherited syphilis. It may come on soon after birth, but it is most common from the tenth to the twentieth year; and, although it is gen-erally accompanied by more or less otorrhœa, it is essentially due to organic changes in the delicate structures of the internal ear; mainly, in all probability, to disease of the

auditory nerves. Inherited syphilis is a fruitful source of deaf-muteism. The loss of hearing nearly always affects both ears.

Ulcers of the tonsils, uvula, palate, and pharynx are not infrequent; they usually come on before the eighth or tenth year, exhibit an excavated appearance, and, if not carefully watched, are apt to produce great havoc in the affected structures. The diagnosis is always easily determined by the peculiar character of the ulcers and their coexistence with syphilitic disease in other parts of the body.

Nodes, enlargement at the junction of the epiphyses with the shafts, hypertrophy, and other affections of the bones of the extremities are very uncommon in infants; but sufficiently frequent in children, especially in the humerus, radius, and ulna, which occasionally suffer simultaneously. Nodes of the phalanges of the fingers—the dactylitis of authors—are sometimes observed. A number of such cases have been under my care at the College Clinic, as well as in private practice. In a few of the cases the affection was congenital. The gummy matter is generally deposited, either simultaneously or successively, in the areolar osseous tissue and between the bone and periosteum, leading to great enlargement and deformity, attended with livid discoloration of the skin, and more or less pain, followed, at length, by suppuration and a bad form of ulcer, often involving several of the phalanges and even the contiguous joints. Nodes in children are occasionally multiple. It is a curious fact that the bones of the lower extremities, which so frequently suffer from syphilis in the adult, are seldom involved in this disease in very young subjects. Marked prominence, with more or less tenderness on percussion, of the frontal protuberance and cranial sutures is often met with, the affected part some-times presenting the appearances of slight exostoses. Syphilitic onychia is most common in very young children.

Inherited syphilitic hypertrophy of the osseous tissue occasionally exists in a remarkable degree, as in a case at the College Clinic, in 1867, in a lad, fourteen years of age, in which the disease was, apparently, entirely limited to the radius, which was enlarged in a most extraordinary degree, both in length and thickness, from one end to the other. The wrist and elbow joints were normal. The right arm had been amputated at the shoulder some months previously, on account of necrosis of the head and shaft of the humerus, attended with destruction of the articular cartilage, and great exhaustion from pain and suppuration. Treatment failed to make any impression upon the hypertrophied bone.

Parrot has recently described an atrophic lesion of the cranial bones in inherited syphilis, in which there is gelatiniform transformation of the osseous tissue. The bones present a worm-eaten appearance, and the metamorphosis begins beneath the periosteum. The change cannot be recognized during life.

The large joints, especially the elbow, knee, and ankle, are liable to suffer during the pro-gress of hereditary syphilis; the attacks are uncommon in early childhood, but are not infre-quent after the fourth year, and are then generally attended with considerable pain, heat, and swelling, attended with more or less effusion of synovial fluid and disorder of the general health. In badly healed or neglected cases, the disease may terminate in abscess, anchylosis, or even complete destruction of the component structures of the affected joints.

Syphilitic periostitis is very uncommon in infants, for the reason that in them all kinds of syphilitic affections are secondary, whereas in children they are tertiary. Nocturnal pains are also of rare occurrence as an effect of inherited syphilis. Syphilis of the testis in infants is uncommon. It is characterized by great hardness of the organ, caused by interstitial hypertrophy of the connective tissue, and is occasionally noticed within a few months after birth, although it is most frequent after the second year.

The gummy tumor of the heart is probably much more frequent in hereditary syphilis than is generally supposed. The disease has been studied with great care by Professor Virchow, who, in 1868 showed me numerous preparations illustrative of its nature and history. The liver also occasionally suffers in a similar manner.

Hemorrhage is an occasional occurrence in hereditary syphilis, manifesting itself at various periods after birth, in some of the numerous outlets, as the mouth, anus, rectum, or vagina; in blotches under the skin, as in purpura; in effusions into the serous sacs; or in deposits in the substance of the brain, lungs, liver, or spleen. I have met with two cases in which fatal hemorrhage proceeded from the stump of the umbilicus of syphilitic children less than ten days old. In whatever form appearing, it is always denotive of a profoundly syphilitic condition of the system, and admits of no relief from treatment.

Affections of the nervous system are not uncommon in inherited syphilis, appearing in various forms, sometimes soon after birth, at other times not until the age of ten, twelve,

or even fifteen years. The most frequent developments are chorea and epilepsy with paralysis of some of the cranial nerves, and affections of the retina, or of this membrane and of the choroid. Hemiplegia, with or without aphasia, is another occasional occurrence. Death in this condition of the system is often sudden and unexpected. Dissection generally reveals the presence of gummy tumors, softened cerebral substance, arterio-capillary constriction, and various albuminoid or protoplasmic nutritive changes.

The development of hereditary syphilis is occasionally postponed until a very late period, as the fifteenth, eighteenth, or twentieth year; and there is reason to believe that the poison may remain latent in the system even for a much longer time. It is an interesting fact that the subjects of hereditary syphilis are either insusceptible of primary syphilis, or, if they contract the malady, that they suffer from it in a modified form.

Finally, hereditary syphilis, by impairing the general health, or, in other words, gradually undermining the powers of life, predisposes to scrofula, rickets, and phthisis. How far it may act as a cause of certain malformations, as harelip, cleft palate, or bifid spine, is still an open question.

Treatment.—The treatment of infantile syphilis is prophylactic and curative. If the mother be suspected to be laboring under a constitutional taint, as she justly may be if she has had several consecutive abortions or miscarriages, or if she is in infirm health, with eruptions upon the skin, a plentiful discharge from the vagina, or an ulcerated condition of the neck of the uterus, she should be promptly put upon a course of mercury and a properly regulated diet, in order to prevent the ill effects of the contaminated state of her blood upon the fœtus, and thus enable the latter to attain its full growth, and the full period of gestation. The mercurial course should be chronic, not acute, and as gentle as possible, lest it should excite abortion; and in most cases it will be beneficial to associate the mineral with the iodide of potassium and some preparation of iron, with a view to a tonic effect upon the general system, which, as already stated, is usually in an impaired and cachectic condition, and, therefore, in need of great attention to raise it to its normal level. The diet should be mild and nutritious, the clothing warm, and the patient well supplied with fresh air.

As soon as the child is born it should be taken from its infected mother, and confided to a sound wet-nurse, as an appropriate diet is absolutely essential to its preservation. If no suitable wet-nurse can be obtained, it should be furnished with an abundant supply of fresh cow's milk, or, what is better, of the milk of the ass, which approaches nearer to human milk, in some of its more important properties, than that of any other animal. The body and limbs should be well protected with flannel, and frequently bathed with tepid water, impregnated with bran, starch, or mucilage, especially if there be eruptions, fissures, or ulcers upon the skin. The child should breathe none but the purest air. The fact is, too much attention cannot be paid to hygienic measures. Cod-liver oil will prove a valuable adjuvant in all cases in which it agrees with the stomach. When the disease is associated with anemia and coldness of the extremities, quinine and iodide of iron must be employed, in combination with brandy, whiskey, or milk punch.

The most important internal remedy is mercury, and it is here that this article often displays its effects to the greatest advantage in neutralizing the specific virus. If any one should be inclined to doubt the efficacy of this medicine, as an antisyphilitic agent, his skepticism will soon vanish if he will take the trouble to watch the progress of the treatment and the good results that will be sure to follow it. If it is not positively a specific, it approaches as nearly to this property in this disease as anything well can, quinine in intermittent fever hardly excepted. The form of exhibition is the bichloride, in doses varying from the fortieth to the fiftieth of a grain three times in twenty-four hours, dissolved in distilled water, or, when there is need of a tonic, in a few drops of Huxham's tincture of bark. This should be steadily continued, with, now and then, a few days' intermission, for a number of weeks, not only until all disease is apparently gone, but for a considerable period after; and it will be well, for the sake of the more complete eradication of the poison, occasionally to recur to the remedy until the child is several years of age. When the disease proves obstinate, the bichloride may generally be advantageously conjoined with the iodide of potassium, from the fourth to the eighth of a grain of the latter being given with each dose of the salt, according to the age of the child.

When the disease appears at a late period of life, as after the eighth, tenth, or fifteenth year, the best plan is to use at once liberal doses of iodide of potassium, as from three to five grains, in combination with the tenth of a grain of bichloride of mercury, thrice in the twenty-four hours. This treatment is particularly indicated in affections of the eye,

ear, throat, nose, and bones. When corrosive sublimate disagrees, or does not seem to reach the case, the most suitable substitute is calomel.

When the body is covered with sores, pustules, or tubercles, a gentle course of mercurial fumigation will be advisable, great care being taken not to carry it to such an extent as to induce debility. Mild dressings may be used in the intervals, of which the best are nitrate of lead, iodoform, or acid nitrate of mercury, properly diluted.

When bichloride of mercury is inefficient or prejudicial, the gray powder may be employed, or, what is preferable, because not liable to cause gastro-intestinal irritation, inunctions with mild mercurial ointment, from half a drachm to a drachm being rubbed upon the inside of the thighs once a day, or a flannel bandage smeared with the ointment, or the twenty per cent. oleate of mercury may be steadily worn around the abdomen. The treatment should be persistently continued until all evidence of the disease has disappeared.

CHAPTER X.

WOUNDS AND CONTUSIONS.

SECT. 1.—GENERAL CONSIDERATIONS.

THE term wound is a generic one, employed to designate all injuries attended with a division of tissue, inflicted by sharp, pointed, or blunt instruments and weapons of every description. The breach, or solution of continuity, may be apparent or concealed; that is, upon and in the skin, as well as the more deep-seated structures, or the skin may retain its integrity, and the wound be strictly subcutaneous.

Wounds are constantly made by the surgeon in the legitimate exercise of his professional duties, as in the removal of limbs, tumors, and urinary calculi, and in the restoration of lost or mutilated parts. In general, however, they are inflicted accidentally, and hence, as this may happen in a great variety of ways, they are very properly arranged under different heads, according to the manner in which they are produced. Thus, a wound is said to be incised when it is caused by a sharp instrument; lacerated, contused, or bruised, when it is made by a blunt body; punctured, when the weapon is narrow and pointed. A gunshot wound is a breach inflicted by a ball. In a poisoned wound the tissues are inoculated with some peculiar virus, either secreted by an appropriate apparatus in the bodies of certain animals, as the bee or snake; contained in the salivary fluid, as in the dog in hydrophobia; or developed after death, as in the human subject in the dead-house. The term penetrating is employed when the wound communicates with a cavity, as a joint, the chest, or the abdomen.

Wounds are also named according to the region of the body which they occupy, or the particular tissues, organ, or cavity which they affect and interest. Thus it is customary to speak of wounds of the head, neck, chest, abdomen, and extremities; of wounds of the skin, muscles, tendons, vessels, and nerves; of wounds of the stomach, heart, lungs, liver, and brain; and of wounds of the joints, pleura, pericardium, and peritoneum. Finally, wounds may be superficial or deep; recent or old; simple or complicated; oblique, transverse, or longitudinal. The most common complications which attend wounds, or which arise during their progress, are, hemorrhage, the presence of foreign matter, abscesses, mortification, erysipelas, septicemia, pyemia, and tetanus. Such accidents, whether occurring singly or in combination, often completely change the character of a wound, rendering complex what was originally perhaps perfectly simple, and dangerous what was, in the first instance, perhaps so insignificant as hardly to attract serious attention.

The characteristic features of wounds will be pointed out in connection with the different classes of injuries to which they relate. The prognosis and treatment will also receive due attention. It will, therefore, be sufficient here to state, in general terms, that they are all productive, each in its own peculiar way, of more or less pain and hemorrhage, and that, in most cases, there is marked retraction of their edges, caused either by their natural resiliency, or by the vulnerating body. The principal exceptions to this rule are in punctured and gunshot wounds, in which, from the peculiarity of their shape, and the manner in which they are inflicted, the latter phenomenon is very uncommon.

Wounds are absorbing surfaces, a fact which should not be lost sight of during their treatment, as through them poisonous substances may readily find their way into the system, and thus either seriously complicate them, or destroy the patient. Recent skin wounds especially possess this quality, but it is hardly less conspicuous in muscular wounds. In granulating wounds the danger is less. The experiments of Renaulton on the virus of glanders and those of Dolin on that of anthrax go to show that the absorption is so rapid that cauterization performed more than ten or fifteen minutes after the inoculation is useless as a means of protecting the system. Davaine finds that punctured wounds are by far the most dangerous of all, as it respects the ingress of poisonous material, and that cauterization to be effective must be very prompt. These facts are of the greatest practical significance, as they point unerringly to the indispensable necessity of the employment of cleanliness and of free drainage in every case of this class of affections.

A not unfrequent occurrence after wounds, especially in nervous, irritable subjects, is *spasm* of the muscles, often accompanied with violent pain and twitching. Such an effect may follow upon almost any injury of this kind, however insignificant, but is most common in punctured, lacerated, and gunshot wounds, in which it not unfrequently entails the most frightful suffering. The stump, after amputation of the leg and thigh, sometimes jerks and twitches in the most distressing manner for hours and even days together ; and spasm of the muscles, in compound fractures, is one of the most common causes of displacement of the ends of the fragments, as well as, in many cases, a source of great pain and annoyance. The spasm generally occurs in paroxysms, coming on during sleep, and suddenly waking up the patient, very much as in coxalgia and disease of other joints. The muscular movements are occasionally very slight, amounting to a mere quivering of very transient duration, and unattended with any starting or jerking.

Emphysema is occasionally noticed in and around wounds. It comes on at a variable period after the receipt of the lesion, and manifestly depends upon different causes. Thus, in wounds of the neck, chest, and abdomen it is usually owing to an escape of air, respectively, from the windpipe, lungs, and intestines. In another class of cases, it is probably due to the accidental introduction of the air at the moment of the injury, or to the entanglement of the external air among the tissues from the peculiar valve-like shape of the wound. Sometimes, again, it is apparently caused by the decomposition of effused fluids ; and cases arise in which it is evidently dependent upon the gas generated during the progress of traumatic gangrene.

However induced, the exciting cause of the emphysema should always be diligently inquired into, as this must necessarily exercise an important influence upon the prognosis and treatment of the case. When present immediately after the receipt of the wound, it is evident that it cannot be due to gangrene or to the decomposition of effused fluids, but that the air must have found its way in, either from the exterior or through some natural cavity. The emphysema is generally more or less circumscribed, occurring as an irregular tumor, of a soft, crepitating character ; but cases occur, as in wounds of the neck and chest, in which it may occupy almost an entire limb, if not the greater portion of the body.

The *scars* left by wounds, even by the most simple incision, are sometimes followed by great disfigurement ; and now and then they are transformed into keloid growths, with a remarkable recurring tendency after extirpation. A cicatrice occasionally presents an unhealthy aspect from the constant irritation to which it is subjected by the friction of the patient's clothes. A morbid condition of the system, especially scurvy and anemia, may also materially influence the nature of such a product. Wounds made by glass, splinters of wood, nails, and similar bodies, are exceedingly prone to be followed by unseemly, indurated, rough, and troublesome scars.

Foreign bodies, containing coloring matter, may, if retained, leave a cicatrice permanently in a dark, unseemly condition. The principal substances likely to cause such an appearance are gunpowder and coal, both of which are often so firmly imbedded in the skin as to render it extremely difficult to dislodge them.

The nature of the cicatrice is generally materially influenced by the character of the granulations which precede its development. If these are firm and healthy, the cicatrice will be likely to be so too : but if they are large, sodden, and œdematous, it will inevitably be soft and thin, abnormally vascular, of a bluish color, and prone to ulceration and even gangrene. An imperfectly organized cicatrice of the abdomen occasionally gives way under the pressure of the contained viscera, and thus becomes a cause of ventral hernia, and the cicatrice of the large wound in certain amputations, as in those of the thigh, sometimes gives way long after the parts are apparently firmly united. Scars, to

which this description applies, are most common in feeble, anemic, or scorbutic subjects, and are evidently due to a defective state of the vital powers interfering with nutrition and the process of repair.

Painful scars are very common after amputations, owing to some peculiar change wrought in the terminal portions of the nerves after such operations. Lacerated, contused, punctured, and gunshot wounds are not unfrequently followed by similar effects. The pain, which often assumes a neuralgic character, is liable to serious exacerbations from the most trivial causes, especially exposure to cold, atmospheric vicissitudes, and disorder of the general health, and, from its persistency and obstinacy, may become a source of great suffering and annoyance, rendering life perhaps almost insupportable.

Keloid tumors, of the spurious variety, originally described by Alibert, often form upon scars without any assignable cause, even after a wound has healed apparently in the most kindly manner. The degeneration usually appears within the first few months after the closure of the wound, forming a hard, firm, irregular cicatrice of a fibrous or fibroplastic character, more or less unseemly, the seat of frequent itching and annoyance, and liable to repullulation after extirpation.

Finally, scars left after the healing of wounds sometimes take on carcinomatous action, the most common form in which it appears being the epithelial. Such an occurrence is most frequent in old scars, and especially in the scars left by burns and scalds constantly irritated by pressure, friction, and other causes of disease.

1. MODE OF DRESSING AND TREATING WOUNDS.

The most important retentive means in the treatment of wounds are adhesive plaster and sutures, aided, if necessary, by the bandage and attention to the position of the injured parts.

There are various substances which are endowed with adhesive properties, and which are therefore well adapted to retain the edges of a wound in contact with each other. Those, however, which are usually employed for this purpose are the common adhesive plaster, collodion, and isinglass plaster.

The old adhesive plaster, so long used in this and other countries, has been entirely superseded by the plaster invented by Dr. Henry A. Martin, of Boston, by whom it was formally introduced to the notice of the profession in 1877. It is essentially composed of the very best Para rubber, Burgundy pitch, and balsam of Tolu, spread upon strongly woven cloth, thoroughly shrunken and freed from every trace of dressing by treating it antiseptically. The advantages of this plaster are indisputable. It is applied without heat or moisture, adheres with extraordinary firmness, is flexible, waterproof, and devoid of irritating properties, is unimpaired by age, light, air, or temperature, and can be removed without leaving any of the adhesive matter on the skin. Mead's plaster also adheres without warming, and possesses highly adhesive properties.

The plaster is cut, as occasion requires, into suitable strips with scissors, carried in the direction of the length of the cloth, not in that of its breadth, as it is much more yielding in the latter than in the former, and therefore liable, when it becomes heated by the skin, to let the edges of the wound gape more or less. Trifling as this precept may appear, it is of great practical importance, and can, therefore, hardly be too strongly insisted upon. When the wound occupies a limb, each strip should be long enough to embrace about three-fourths of its circumference; on no account should it completely encircle it, lest it impede the return of venous blood, and cause pain and tension. The width of each strip should be uniform, and vary, on an average, from half an inch to an inch, according to the exigencies of the case.

Previously to applying the plaster, the surface of the skin should be divested of hair, and well dried with a soft cloth, as the least moisture prevents it from adhering. The shaving of the parts is necessary to facilitate the removal of the plaster, which would otherwise be difficult and painful, and which might, by its traction, even seriously compromise the safety of the adhesive process. These important preliminaries being disposed of, all bleeding having ceased, and the edges of the wound being carefully held together by an assistant, each strip is applied in such a manner that its centre shall correspond with the wound, while each extremity firmly grasps the opposite side. If the wound is very long and deep, the first strip should be stretched across the middle, which thus becomes the starting point of all the rest. The interval between each two strips should not, on an average, exceed the eighth or fourth of an inch, as this will afford ample space for the drainage of blood, serum, and lymph, of which there will generally be more

or less after every injury of this description, especially if it be of considerable extent. Care must be taken that the adhesive strips are laid down in as smooth and even a manner as possible ; hence, the parts should always be put in the position in which it is intended to keep them during the treatment. If the strips rise up in folds, or are partially detached, they should immediately be replaced by others, more skilfully applied. Finally, it is very necessary, on the one hand, not to invert the edges of the wound or to draw them together too firmly, and, on the other, not to approximate them so loosely as to endanger their partial separation. In short, everything should be done in the most neat, accurate, workmanlike manner.

Isinglass plaster is not used so much now as formerly. It is said to be less irritating than the common plaster, and equally as adhesive. Moreover, it is alleged that insinglass, if spread upon gauze, will, by its transparency, admit of complete surveillance of the wound, the surgeon being able to witness the changes going on in and around it. Notwithstanding these supposed advantages over common adhesive plaster, my conviction is that the latter, as prepared by the modern pharmaceutist, is decidedly superior to it, in every particular. The idea that common adhesive plaster is apt to provoke erysipelas and ulceration of the skin is in great measure, if not wholly, chimerical ; at all events, I have seldom met with such an occurrence. In the next place, it is much stronger than isinglass plaster, and therefore affords better support to the parts. Thirdly, it is less liable to be prematurely detached ; and, lastly, although it is opaque, yet as there is always an interval left between each two strips for drainage, it is obvious that it cannot in the slightest degree interfere with the examination of the wound and its vicinity. I, therefore, generally limit the use of isinglass plaster to the dressing of small wounds or little cuts, and employ the common plaster for wounds of large size. The principles regulating its application do not differ from those already laid down. The strips should be of appropriate length and width, and moistened on the glazed surface with a sponge pressed out of cold water.

Glycerine adhesive plaster, employed by some of our surgeons, is liable to the same objections as isinglass plaster ; it makes, however, a very neat dressing, and is well adapted to the more simple forms of wounds.

Court plaster, as it is called, is seldom used by the scientific surgeon, as, from its irritating nature, it is very apt to inflame the parts, and thus occasion overaction. It is composed of gum benzoin and isinglass, dissolved in rectified spirit, and brushed over silk, with a coating of Chian turpentine, to prevent it from cracking.

The substance known as skin plaster is well adapted as a dressing for very small, superficial wounds, as it is perfectly transparent, very smooth, and non-irritant, but is not strong enough for large ones. It is composed of sheep's omentum, coated with a solution of isinglass, and is applied to the parts previously wet with a sponge.

Collodion, first used for surgical purposes by Dr. J. P. Maynard, of Boston, in 1847, consists of a solution of gun cotton in ether, with the addition of a little alcohol. It is a transparent, colorless fluid, of a syrupy consistence, which, when applied to a dry surface, allows of the rapid escape of the ether, leaving a thin, bluish film, possessed of remarkably adhesive and contractile properties. As it is impervious to water, it is less liable to be prematurely detached than the isinglass or common plaster. Put upon wounds or abraded surfaces, it causes sharp pain, which, however, always speedily subsides. It may be applied by means of a camel-hair pencil, or a small brush, directly to the affected parts, as in the case of small, superficial cuts ; or upon strips of linen, muslin, patent lint, or Tarlton gauze, of suitable width and length, when the wound is so large and deep as to require firm support. As the ether evaporates very rapidly, the dressing should be applied with as much celerity as possible, everything being thoroughly arranged beforehand, and the edges of the wound well dried and supported by an assistant. Collodion makes an excellent dressing in wounds of the neck and face, as well as in other movable regions of the body, and in all cases where it is particularly desirable to exclude the air.

Styptic colloid, introduced to the notice of the profession by Dr. B. W. Richardson, of London, is a styptic, antiseptic, and deodorizer, and affords a complete means of excluding air from wounded or ulcerated surfaces. It is composed of xyloidine, a substance resembling gun cotton, dissolved in ether and saturated with tannic acid. Applied in a similar manner to collodion, the blood and secretions permeate the cotton as the ether vaporizes, and the albumen is coagulated by the tannic acid, forming a leathery membrane, while the cotton imparts substance and adhesive qualities to the mass. To remove the dressing, it is only necessary to moisten it with a mixture of alcohol and ether, or with alcohol and water warmed a little above the temperature of the body.

India-rubber possesses strong adhesive qualities, and an excellent plaster may be prepared from it by spreading a solution of it, with a stiff brush, upon gauze, silk, or thin muslin, after the fashion of collodion. One great advantage which it possesses over most other material is that it is completely impermeable by water.

The substance, whatever it may be, should be retained until it ceases to answer the object for which it was applied. The moment it becomes a source of irritation, loses its hold, or obstructs drainage, it should be removed, the substitute material being always properly arranged beforehand, lest the parts should be unduly exposed to the air, or insufficiently supported. Surgeons often err in being too anxious to meddle with the adhesive plaster; too early interference has a tendency to interrupt the adhesive process, and may, in persons of a bad, irritable constitution, give rise to erysipelas and other accidents. I have, more than once, after severe operations, retained all the original strips for upwards of a fortnight; until, in fact, complete cicatrization had taken place. Such good luck, however, is rare; and it more generally happens that the dressings, plaster and all, have to be changed at the end of the second, or, at furthest, the third day. Much, of course, will depend, in every case, upon the state of the weather, the size and situation of the wound, and the amount and character of the discharges.

When the wound is extensive, only a few strips should be taken off at a time, otherwise there will be danger of separating its edges. Before the dressing is readjusted, the parts should be thoroughly cleansed with tepid water, pressed from a sponge held at some distance or applied with a syringe; no wiping must be done, nor must the wound be rudely squeezed. Any matter that may be at the bottom or between its edges should be pressed out in the most gentle and careful manner, rough manipulation being not only painful, but injurious to reparative action. Sometimes the necessary cleanliness may readily be effected with a moist sponge or soft cloth passed lightly over the surface. Great skill is required in removing the plaster to the best advantage of the parts. Each strip should be raised by taking hold of one extremity with the thumb and finger of one hand, while the other hand is engaged in supporting the wound; the other end being treated in a similar manner, the portion corresponding with the wound is lifted off last, and thus all danger of injury is effectually obviated.

The principal sutures employed in surgery are the interrupted, twisted, continued, and quilled. There are several others which will be described in their proper place.

The *interrupted suture*, which is more frequently employed than any other, is made with a needle, either straight or slightly curved, and armed with a single, well-waxed ligature, either of silk or of linen, as may be found most convenient; for, in a practical point of view, it is really altogether immaterial which it is. The instrument, which should always be very sharp, and in the best possible order, is introduced through the edge of the wound, from without inwards, at a suitable distance from its surface, and then pushed from within outwards at precisely the same point at the opposite side, leaving the thread in its track. A second stitch is then to be taken in a similar manner, and thus the operation is continued until a sufficient number has been introduced, when the ends of each ligature are to be tied with a reef-knot, and cut off close. The distance at which the needle should be inserted from the wound must of course vary in different cases and in different regions of the body; but, in general, it should not be less than a line, nor more than a quarter of an inch.

Fig. 91.

Interrupted Suture.

The depth at which it is passed should be such as to admit of accurate approximation of the wound, about one-third of the thickness of the edge being behind and the rest in front of the needle. In no case of superficial wound should the instrument embrace muscular or aponeurotic substance. The interval between each two stitches must also necessarily vary, according to circumstances, from a few lines to an inch or more, and should be supported, after the sutures have been tied, with adhesive plaster, as in fig. 91. If the wound is very small, it may be sewed up with a common cambric needle, and a proportionately delicate thread.

The needles for sewing up wounds are of various forms and sizes, straight or curved, short or long, according to the object to be fulfilled, or the nature of the parts affected. For sewing up any wound of considerable size, the instrument should, as a rule, be perfectly straight, and not less than two and a half to three inches in length, with a sharp rounded point, or a point slightly curved and spear-shaped. In
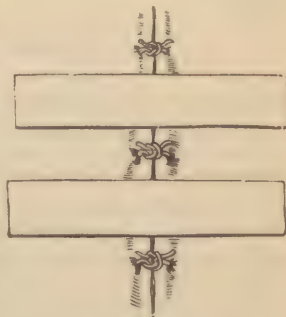
certain situations, as in wounds of the face, a curved needle will be found to be most convenient. Very short curved instruments are necessary when we wish to sew up a fissure of the palate, or a ruptured vesico-vaginal septum. A needle with an immovable handle, such a one as is generally put up in our pocket cases, is a very useful instrument.

The *twisted suture* is made by introducing a pin through the edges of the wound, and passing a thread round it, so as to confine it in its place. It makes an admirable retentive apparatus, but is of more limited application than the interrupted suture. From the fact that it is generally employed in the treatment of harelip, it is often called the harelip suture.

Various instruments are employed for making the twisted suture. What is called the lady's toilet pin, a round steel pin, very sharp-pointed, and furnished with a glass head, is in the main the best; it readily penetrates the tissues, and creates less irritation than the common sewing-needle, formerly so much employed for this purpose. Fifty years ago surgeons were in the habit of using a silver needle, with a movable steel point, as seen in fig. 92; a cumbersome, awkward instrument, now happily discarded. Dieffenbach recom-

Fig. 92.

Old Suture Pin.

mended what is called the insect pin, which, however, has never come into general vogue, at least not on this side of the Atlantic. In small wounds of the forehead, face, and neck, in which it is of so much importance to prevent the occurrence of a scar, I have been in the habit, ever since I entered the profession, of employing a very delicate gold pin, with a head of sealing wax, and there is not, I am sure, any article better suited to fulfil such an indication. Insusceptible of oxidation, it causes no irritation, and may therefore be retained for almost any length of time without detriment to the parts.

Whatever kind of pin be employed, transfixion is effected in the same manner as in the common interrupted suture, the thumb and finger being generally quite sufficient for the purpose. In some situations, however, as, for example, in certain parts of the face, the operation will be greatly facilitated by the use of a special pair of forceps, or the pin-conductor, fig. 93, of Dr. Gurdon Buck, an instrument easily obtained at any of the cutler shops. The wrapping material, consisting of ordinary thread or silk, smooth and well waxed, to prevent the imbibition of the secretions, is wound around the pin elliptically, as in fig. 94, as it arranges itself much more evenly and efficiently when thus applied than when it is carried around the pin in the form of an 8, as in fig. 95, and as is so gene-

Fig. 93.   Fig. 94.   Fig. 95.

Buck's Suture Pin-Conductor.   Twisted Suture.
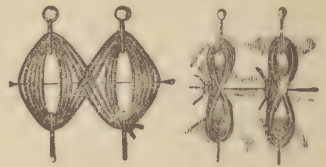
rally done in this and other countries. As many pins or needles having been inserted as may be deemed advisable, the threads are passed from one to the other diagonally across the gap, so as to effect complete apposition there also, and so obviate the necessity for using adhesive plaster. Finally, the threads being tied, the operation is completed by cutting off the points of the pins with a pair of pliers, fig. 96, otherwise they may hurt the patient, or be caught in his clothes.

Instead of confining the pin with a thread, Rigal uses a thin narrow ring of gum elastic, which answers the purpose most admirably, as it draws the parts firmly and evenly together. The only objection to it is that it may cause too much pressure when there is an unusual amount of swelling in the lips of the wound. The late Dr. Washington L. Atlee employed this form of suture in many of his ovariotomy cases, under the impression that it possessed decided advantages over the more ordinary contrivances. The annexed cut, fig. 97, exhibits the shape and mode of application of the ring.

The period during which the pins are retained varies from two to three or four days, according to the circumstances of the case. Their removal should be effected with great

Fig. 96.
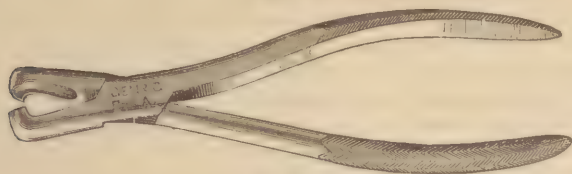
Pin Pliers.

Fig. 97.
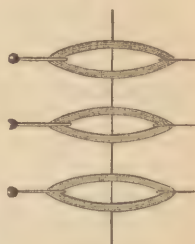
India-rubber Sutures.

care, in a direction contrary to that of their introduction, the parts being well supported at the time. As the threads are generally firmly glued to the surface and edges of the wound, it is well to let them remain until they drop off of their own accord, as they usually do in a day or two after the withdrawal of the pins. The support thus afforded is often of great service to the imperfectly organized bond of union, and its premature removal sometimes necessitates the employment of adhesive plaster, or the insertion of a new pin.

The *continued suture*, fig. 98, is similar to that used by the glover, on which account it is generally known as the glover's suture. It is made with a needle armed with a suitable thread, which is passed diagonally from one side of the wound to the other, on the same principle as in the interrupted suture. Its use is almost exclusively restricted to the treatment of wounds of the intestines, in connection with which it will again be noticed.

Fig. 98.

The Glover's or Continued Suture.

Fig. 99.

Quilled Suture.

The *quilled suture*, fig. 99, so called from the fact that it was originally made with the assistance of two quills, is employed chiefly in the treatment of lacerations of the perineum, with a view of effecting more even and accurate contact of the opposed surfaces. The older surgeons were in the habit of using it in sewing up deep muscular wounds, as those of the thigh and abdomen. No one, however, thinks of resorting to it for such a purpose at the present day; for in the latter case the object can be attained much more easily by the ordinary interrupted suture, extending down nearly to the peritoneum, and in the former by methodical support with the compress and bandage. The quilled suture is made by passing a stout double thread through the sides of the wound, at intervals of an inch or an inch and a half, and tying its ends over a piece of bougie, quill, wood, or whalebone, lying parallel with the cut, but about half an inch from it.

Although sutures undoubtedly act as foreign bodies, necessarily exciting a certain degree of irritation in the tissues into which they are inserted, I have by no means that

dread of them which they seem to have inspired in the minds of many practitioners. I have rarely witnessed any ill effects from their employment, and when anything of the kind did occur, the fault was generally due more to the indiscretion of the surgeon, or to the want of stamina on the part of the patient, than to any untoward operation of the sutures themselves. Provided the threads, or needles and threads, are clean, of suitable size, and properly inserted, the constitution of the patient in good condition, and the wounded structures in a tolerably sound state, it is difficult to understand how they could become a source of serious irritation, much less of erysipelas or severe ulceration, effects which have all been charged to their action. It is, therefore, I conceive, a good plan to use them freely, and to allow them to remain so long as they seem to answer the purpose for which they were introduced. The moment this object is attained, or they are found to be productive of injury, they should be withdrawn.

The best material for sutures unquestionably is metal, and it matters not, according to my experience, whether this is silver or iron, provided it is properly tempered, perfectly smooth, and sufficiently thin and pliant. This substance, although noticed in connection with this subject by different writers, was first introduced into regular practice by Dr. J. Marion Sims, and is one of the greatest additions to the armamentarium of the present day.

The advantages of the metallic suture over every other are that it is entirely free from all irritating properties, and that it may be retained for weeks or even months, as I have repeatedly known it to be, without provoking suppurative action, so common when silk or thread is employed.

In England, at the suggestion of Mr. Clover, a very thin copper wire covered with gutta percha—in fact, a miniature telegraph wire—is occasionally employed for closing wounds. It does not cause any irritation, is easily introduced with a fine sewing-needle, and is so soft as to be readily cut and tied into a knot, like ordinary thread.

Wire is introduced in the same manner as thread, the short end being firmly twisted round the long one ; or, instead of this, it is tied with a double knot, as may also be readily done when the wire is very thin and flexible. Numerous needles have been devised for facilitating the insertion of the wire, but it is questionable whether they possess any particular advantage over the one in common use. Perhaps the most unexceptionable one is one with two holes, with a vertical groove on each side.

The annexed engravings will serve to convey an idea of some of the best forms of this kind of needles. Fig. 100 represents Mr. Price's instrument ; it is grooved on both sur-

Fig. 100.

Price's Needle for Wire Suture.

faces, and is pierced with two holes, nearly half an inch apart, the wire being passed from the lower to the upper, and then doubled and twisted at the end to hold it. Mr. Murray's needle, fig. 101, has a groove and open box end, while Mr. Lister's, fig. 102, has a single

Fig. 101.   Fig. 102.
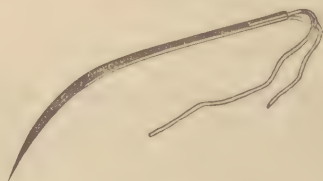
Murray's Needle.   Lister's Needle.

eye and a groove on the side. Ingenious contrivances of a similar kind have been constructed by Dr. Levis and Dr. Goddard, of this city.

For introducing wire, both in superficial and deep-seated wounds, the tubular needle, represented in fig. 103, will be found a convenient instrument.

In removing the wire suture, care must be taken that the edges of the wound be not forcibly separated. To prevent this, the loop should be cut on one side very close to the border of the wound, when the twist may be seized with the forceps, and the wire gently

drawn out. The length of time during which the suture is retained must depend upon circumstances. From three to five days is a good average period.

Fig. 103.

Tubular Needle.

Horsehair prepared by boiling for a short time in a weak solution of sodium, is occasionally employed as a material for the interrupted suture, and answers excellently well, as it is sufficiently strong for any wound, however large or deep, and does not absorb fluids or cause irritation. It may, likewise, be retained indefinitely. To prevent the ends from untying themselves, the reef-knot must be used.

Carbolized catgut is now being employed as a material for sutures in connection with the antiseptic treatment of wounds; but it should be prepared with chromic acid in order that it may resist the solvent action of the tissues until the process of union is completed.

Rest and easy position are essential elements in the treatment of wounds. If the part be exercised, or moved, it will be difficult, if not impossible, to preserve apposition, and to limit inflammatory action. If the wound be transverse, and seated in an extremity, it will inevitably be torn open, if the muscles which pass along it are not maintained in a relaxed condition. Thus, if the wound involve the front of the thigh, the limb is extended, and flexed if it affect the posterior aspect; the muscles immediately concerned in the lesion being thus in each case put in a state of perfect repose.

In very large and deep wounds, it is hardly possible to keep the edges in contact, in their entire extent, without the aid of compresses and bandages, more especially when they involve large and numerous muscles, as, for example, in wounds of the thigh. In such a case, adhesive plasters and sutures, however skilfully applied, would scarcely be sufficient to afford the parts the support which is necessary to maintain them in perfect apposition. More or less separation would almost be inevitable. To fulfil this indication, so important to the adhesive process, it is indispensably necessary to lay a stout compress or piece of sponge along each side of the limb, opposite the deep portion of the wound, and to confine it with a roller, extending from the toes upwards as far nearly as the groin. In all lesions of this description, whether the result of accident or of operation, great care must be taken to prevent the retention of fluids, otherwise suppuration will take place instead of union by the first intention. Large intervals should be left between the adhesive strips, and holes should be cut in the bandage where it lies over the affected part: in some cases, indeed, it will even be necessary to leave a small tent or tube at the bottom of the wound, at the most dependent point, to drain off the discharges.

Fig. 104.   Fig. 105.

Invaginated Bandage for Longitudinal Wounds.

The most suitable bandage for supporting wounded parts is the common roller, carried upwards from the distal portion of the limb to a short distance beyond the seat of the injury. The invaginated bandage, represented in figs. 104 and 105, and formerly so much in vogue, is a dangerous contrivance, unworthy of scientific surgery.

When all foreign substances have been removed, when hemorrhage has been checked, and when its surfaces have been accurately approximated without tension, and are properly supported, due provision having been made for the escape of the secretions, a wound is placed in the best possible condition for repair, and the less it is interfered with the more likely will it be, all other things being equal, to do well. Meddlesome surgery cannot be too pointedly condemned, for it is hardly less pernicious than the slovenly surgery still so common at the present day, especially in private practice. The modern treatment of wounds has been carried to the very verge of simplicity, and it is difficult to see how it could possibly be improved, although it is doubtless still susceptible of important modifications. When the

parts are merely divided, all that is generally necessary is to put them in accurate con-
tact, and to maintain them for a certain period in an easy, elevated, quiet, and relaxed
condition. When the wound is very large, as after the amputation of a limb, or the
extirpation of the mammary gland, I generally cover the surface with a pledget of lint
wet with olive oil or cosmoline, to prevent the contact of the air and thus diminish the
chances of profuse suppuration.

I have never found any appreciable benefit in such a case from the use of antiseptic
dressings, although they are regarded by many surgeons as most valuable accessories.
The antiseptic method, when strictly adhered to, demands rigid attention to minute
details, so that it has been modified in various ways, of which the most popular appears
to consist in irrigating or washing the wound with a solution of carbolic acid, boracic
acid, salicylic acid, benzoic acid, thymol, oil of eucalyptus, chloride of zinc, or pure
alcohol, and afterwards enveloping the part in cotton-wool or absorbent cotton. The
merits of ordinary cotton-wool in preventing the ingress of microscopic organisms from
the surrounding atmosphere are justly praised by Guérin, Gamgee, Little, of New York,
and the late Dr. Green, of Portland, and it is also certainly useful for affording gentle
and systematic compression. At the present day, carbolic acid is falling into desuetude.
As I have pointed out in the section on septicemia and pyemia, it does not prevent the
development of micrococci and bacteria in the pus of wounds, and its employment has
not only frequently given rise to serious symptoms of poisoning, but it has been followed
by death in a number of instances.

Cold water-dressing may be required, with a proper regulation of the diet and a mild
aperient when there is danger of overaction. In contused, lacerated, punctured, and
gunshot wounds, cold water-dressing, either alone or in union with opium, arnica, lauda-
num, or laudanum and acetate of lead, may generally be advantageously employed from
the beginning; or, instead of this, warm water or a cataplasm may be used, especially
when there is a tendency to suppuration or sloughing. Leeching and more active general
means, with opium to allay pain and to induce sleep, may be required when high in-
flammation with violent traumatic fever arises, provided there has not been any severe
shock or great loss of blood. The dressings must not be allowed to become hard and dry
over the wound, nor should they oppress by their weight, otherwise they will be sure to
prove hurtful and offensive. The discharges should be frequently removed with the
sponge or syringe, the sickly odor exhaled from the raw surfaces being neutralized by the
proper use of the chlorides, Labarraque's solution, or weak lotions of permanganate of
potassium. The atmosphere of the patient's apartment should be kept in as sweet and
pure a condition as possible by attention to ventilation; in short, everything should be
done to promote nature's efforts at restoration.

If the action in the wound be languid, some mildly stimulating wash must be employed,
as a drachm of tincture of myrrh to a pint of water, a weak solution of nitric acid or
nitrate of silver, or the red lotion, as it is termed, consisting of two grains of sulphate of
zinc to the ounce of water, with a sufficiency of spirit of lavender to give it color and
fragrance. Creasote water is also a very efficient application, and occasionally nothing
answers so well as water and alcohol, water and spirit of camphor, Labarraque's solution,
or a solution of chloride of zinc, in the proportion of two to five grains to the ounce of
water. Most of these lotions are highly detergent and antiseptic, exciting new action,
allaying fetor, and promoting the granulating process. Conjoined with these remedies must
be proper constitutional means, as a generous diet, wine, porter, or brandy, and quinine,
either alone, or, what is better, combined with tincture of chloride of iron. Such treat-
ment, which will often be demanded even in the more simple cases of wounds, is impera-
tively required when there has been excessive shock or great loss of blood, causing a
severe drain upon the nervous and vascular systems, with a tendency to a low form of
fever, erysipelas, septicemia or pyemia.

A wound sometimes assumes a diphtheritic aspect, becoming incrusted, either uniformly
or in patches, with unorganizable lymph, of variable thickness and consistence, and of a
yellowish, whitish, or greenish color. The occurrence is commonly associated with the
diphtheritic diathesis, and is most frequently met with in persons of a dilapidated consti-
tution, especially among the inmates of crowded, ill-ventilated hospitals, in which it
occasionally exhibits an epidemic tendency, so that hardly any open surface, whether
recent or chronic, or however induced, escapes. Blisters, leech-bites, and the little wound
made in venesection, have all been known to be promptly invaded by it during the pre-
valence of this tendency.

When a wound is thus attacked, it at once puts on an unhealthy appearance; the pro-

cess of repair is effectually checked ; and the discharge either dries up, or assumes a serous, bloody, or ichorous character, at the same time that it exhales a mawkish, sickening odor. Any granulations that may have existed are speedily destroyed, or transformed into pale, flabby bodies, enfeebled and partially devitalized. The edges of the wound are swollen and œdematous, while the surrounding surface is inflamed and not unfrequently erysipelatous. In the more severe forms of this complication, the parts run into phagedena, if not into actual gangrene ; the pain is unusually severe; and the system soon falls into a low, typhoid condition, either eventuating in death, or in ultimate but tardy convalescence.

The treatment consists in isolation of the wounded, the employment of supporting measures, especially iron and quinine, the application of local stimulants, as nitrate of silver and lotions of permanganate of potassium, acid nitrate of mercury, or chloride of zinc, and free ventilation of the infected apartments.

Erysipelas, as a consequence of a wound, usually sets in within the first forty-eight hours after the accident, in the form of a reddish blush of the skin accompanied by the formation of delicate vesicles, a slight burning, itching pain, and more or less swelling, the point of the finger readily leaving its impression upon the affected surface. The wound soon assumes an unhealthy aspect, the discharge seemingly decreases or altogether disappears, and the plasma that is poured out is speedily devitalized. The constitutional symptoms are denotive of a depraved condition of the bloodvessels, and, in the more severe cases, typhomania often makes its appearance early in the attack. Occasionally the erysipelas breaks out upon the body of the patient without invading the wound, and such cases, of which a considerable number have fallen under my immediate observation, are generally peculiarly dangerous, as they are indicative of an uncommonly disordered and depraved state of the system. The chief remedies in the treatment of traumatic erysipelas are quinine and iron with milk punch, beef essence, and fresh air, and the application of iodine with emollient cataplasms and solutions of acetate of lead, frequently renewed.

If the wound be assailed by gangrene or phagedena, the topical remedies most likely to prove useful are nitric acid, carbolic acid, nitrate of silver, bromine, iodoform, permanganate of potassium, and acid nitrate of mercury, the latter being especially entitled to our confidence for its well-known efficacy in arresting morbid action. Sometimes these substances may be advantageously employed in a pure state ; in general, however, they should be very greatly diluted, otherwise they will be productive of severe suffering, if not also of positive injury.

The cicatrization of a granulating wound may generally be very materially expedited by skin-grafting, performed after the manner described in the chapter on Minor Surgery. The operation is especially adapted to cases attended with great destruction of integument. As many as a dozen, fifteen, or even twenty grafts may be inserted at one time, at a distance of eight or ten lines from one another ; repetition being occasionally effected if the cicatrization do not advance sufficiently rapidly.

The spasm and jerking consequent upon wounds, whether accidental or inflicted by the surgeon's knife, are best controlled by anodynes, especially hypodermic injections of morphia, the bromides, chloral, valerian, and choloroform, with the addition of the bandage and lotions of aconite and laudanum. Attention to posture is generally of great moment ; and in many cases, especially in the treatment of wounds after resections of the joints, in compound fractures, and dislocations, ease and perfect rest can only be secured by means of splints.

The emphysema which occasionally follows upon such injuries must be treated according to the nature of the exciting cause. In general the air gradually disappears spontaneously ; when it does not, and the symptoms are at all urgent, relief must be sought by a few punctures or small incisions.

Unhealthy scars, the result of unsound granulations, and other causes, must be treated with solid nitrate of silver, or some slightly stimulating unguent, as the dilute ointment of nitrate of mercury, aided by multiple punctures or scarifications and gentle compression. Hard, elevated, unseemly scars must be removed with the knife, the wound being afterwards treated upon general principles. Before doing this, however, great care should be taken to prepare the system properly, otherwise the parts may be seized with erysipelas, or a bad cicatrice may be succeeded by a worse one.

Scars left by incised wounds inflicted in early life, whether accidentally or designedly, generally completely disappear with the progress of age. The inodular tissue, unless very abundant, gradually assumes the properties of the native structures in its vicinity, and eventually resembles them so closely as to render it impossible to detect any difference.

When a vessel of considerable size is divided, the only plan is to secure it at once with

a suitable ligature. If some time, however, has elapsed since the occurrence of the injury, the artery will not only be inflamed and more or less softened in its texture, but materially changed in its relations by deposits of lymph, and, perhaps, even by the presence of pus. A ligature, applied to a vessel in such a condition, will be almost sure to be detached before the natural process of repair has advanced sufficiently far to form a firm internal clot. Besides, the difficulty of finding such a vessel is generally very great. A tedious dissection, often painful and bloody, is required to expose it; and when, at length, the object is attained, the surgeon has the mortification to discover that it does not answer the purpose. The parts slough or ulcerate, the ligature is cast off prematurely, and a copious hemorrhage again ensues; and thus the case is apt to continue until the patient is completely exhausted. Instead of pursuing such a useless and dangerous course as this, no time should be lost in securing the affected vessel by acupressure, the needle being passed underneath it in such a manner as to include a large quantity of the neighboring tissues. This may occasionally be done, as when the vessel is comparatively superficial, without any previous dissection, by pushing the needle through the skin. It is just in such a case as this that acupressure, I conceive, finds its chief advantage; effectually arresting the flow of blood, and yet not, like the ligature, irritating the artery.

When the case does not admit either of ligation or of acupressure, the only resource is the employment of styptics and systematic compression, which often answer the purpose very satisfactorily, even when the hemorrhage proceeds from an artery of considerable magnitude, as, for example, the axillary or brachial. Dr. James M. Holloway, formerly of the army, has adduced a number of instances of consecutive and indeterminate hemorrhage, consequent upon gunshot wounds, treated successfully in this way, and my own experience fully corroborates the propriety of the practice. His paper upon the subject may be found in the American Journal of the Medical Sciences for October, 1865, and is well worthy of an attentive perusal.

The development of *maggots* in wounds occurs chiefly in hot weather, but I have also seen it in the autumn and early part of winter, in consequence of the artificial heat of the patient's apartment. In tropical climates the formation of maggots in wounds and ulcers is almost unavoidable, despite the best directed efforts to prevent it. The soldiers in Egypt and Syria, under Larrey, and our troops during the war with Mexico, suffered greatly from this cause. Dr. Proctor informed me that wounds, however carefully cleansed in the morning, were found, in the evening, to contain large numbers of these worms, and, if the slightest neglect took place, they speedily collected in incredible quantities, and of prodigious size, their diameter equalling that of a small goose-quill, while their length ranged from three to nine lines. The soldiers had a great horror of them, and, from the disposition which they evinced to burrow deeply among the muscles, they were productive of no little pain and distress.

The best preventive of this occurrence is cleanliness, with a frequent change of dressing, and burying the affected parts in light bran, or carbolized dry earth, so as to place them beyond the reach of flies, which, under almost any other mode of management, are sure to find their way to the wounded surface, the slightest crevice affording them access to the much coveted spot. Moisture and a high temperature are the causes which most rapidly conduce to the formation of maggots. The means that prove most destructive to them are olive oil, spirit of turpentine, creasote, and alkaline solutions, particularly chlorinated sodium. Dr. Atkinson, of the British army, has found no remedy so efficacious as calomel, sprinkled upon the wound, or blown into it from a quill. Dr. Neudörfer, formerly Surgeon-in-chief of the Austrian army in Mexico, informs me that the most speedily destructive remedy he has ever tried is petroleum. Olive oil would probably be quite as effective.

Wounded persons should never be crowded together in the same apartment, as the effluvia arising from their sores, their persons, and their excretions cannot fail to contaminate the atmosphere, and thus become a prolific source of disease and death. Much of the mortality attendant upon gunshot wounds, in times of war, when segregation of the wounded is impracticable, is doubtless due to this cause. Wounds in syphilitic persons are occasionally slow in healing, and may, if irritated, assume the characteristics of syphilitic ulcers. The proper remedy, in such an event, would be a mild mercurial one.

The fever which follows upon these lesions, usually called traumatic, wound, or surgical fever, is greatly influenced in its character by the violence of the injury, the amount of shock and loss of blood, the nature of the parts involved, the constitution of the patient, the condition of the atmosphere, and the nature of the after-treatment. Arising generally within the first six or eight hours after the accident, it is commonly ushered in by slight

chilly sensations, alternating with flushes of heat, and succeeded by disturbance of the pulse, headache, anxiety, thirst, restlessness, heat of skin, loss of appetite, and scanty, high-colored urine. The pulse is usually strong and full, except when there is great depression of the vital powers, when it is generally very feeble, small, frequent, jerking, or even somewhat wiry. The bowels are constipated, the sleep is disordered, and the mind often wanders. Such a fever is well designated as sthenic, in contradistinction to the asthenic, so commonly met with in all low states of the system, whether induced by violent contusions and lacerations, suppurative inflammation, erysipelas, pyemia, the penetration of a large joint, the extravasation of some irritating fluid, as bile or urine, or the coexistence of serious internal disease.

Typhoid traumatic fever, always an occurrence of evil import, is essentially characterized by delirium, frequently of a low-muttering character, dryness of the tongue, sordes on the gums and teeth, tympanites, excessive thirst, nausea, want of appetite, great feebleness and frequency of the pulse, and coldness of the extremities, with a sense of excessive exhaustion. The wound in such a condition of the system has always an unhealthy appearance; the granulations, if there be any, are pale, flabby, and œdematous, while the attendant discharge is thin, sanious, watery, and offensive, exhaling an odor not unlike that of a macerating tub.

2. HEALING OF WOUNDS.

The parts having been properly adjusted, the duty of the surgeon, as far as manipulation is concerned, is temporarily at an end. Nature, the physician of wounds, as she was called by Paracelsus, must do the rest. "Warily," says this eccentric man, in his "Great Surgery," published in 1536, "warily must the surgeon take heed not to remove or interfere with Nature's balsam, but protect and defend it in its working and virtue. It is the nature of flesh to possess in itself an innate balsam which healeth wounds. Every limb has its own healing in itself; Nature has her own doctor in every limb; wherefore every chirurgeon should know that it is not he, but Nature, who heals. What do wounds need? Nothing. Inasmuch as the flesh grows from within outwards, and not from without inwards, so the surgery of wounds is a mere defensive, to prevent Nature from suffering any accident from without, in order that she may proceed unchecked in her operations." If these sentiments, uttered more than three centuries ago, could only be firmly impressed upon the mind of the modern surgeon, there would be much less meddlesome practice of every kind than there is now, notwithstanding our boasted knowledge, and our contempt for the fathers of the profession.

Modern surgeons have described five distinct modes in which wounds are supposed to heal. The first is by immediate union, or the direct growing together of the raw surfaces; the second, by scabbing, or the formation of a crust of blood upon the wound; the third, by the effusion of lymph, and the conversion of this substance into connective tissue; the fourth, by granulation, and the development of epithelial matter; and the last, by the junction, coalescence, or inosculation of granulation with granulation. The old doctrine, so ably advocated by Hunter, and so long entertained by practitioners generally, assumes that there are only two modes of cure; the one consisting in union by the first intention, primary adhesion, or adhesive inflammation, and the second in the formation of granulations, filling up the gap, and thus repairing the injury, the last stage of the process being the development of new skin. This latter mode of repair constitutes what was so long known in the schools as union by the second intention, or union by granulation.

The idea that *immediate union* of a wound may occur was first advanced by Dr. James Macartney, of Dublin. It assumes that two raw surfaces, laid closely and evenly together, will promptly coalesce with each other, independently of inflammation and effusion of plasma, vessel inosculating, as it were, with vessel, muscular fibre uniting with muscular fibre, skin adhering to skin, and nerve becoming again continuous with nerve. It is alleged, it is true, that this occurrence is uncommon, and that it requires for its production complete homogeneity of tissue, a good constitution, an entire absence of local inflammation, and the greatest possible caution in the management of the parts. When these conditions are present, it is asserted that even large wounds, such, for example, as are made in the extirpation of the mammary gland, or the amputation of the thigh, are capable of this kind of union, an assertion which is contrary alike to sound reasoning and correct observation. In discussing this question, it must be borne in mind that different textures possess, as is well known, different faculties of furnishing plastic matter, as well as of removing it after it has been deposited. Thus, in amputation of the leg, when the flap is

exposed to the air, the muscles, fibrous membranes, skin, and connective tissue are much more rapidly glazed with lymph than adipose substance, vessels, or bone, the latter of which, in fact, rarely exhibits any evidence of its presence under several days.

If we take into consideration all the circumstances that can be brought to bear upon this question; the fact that all injuries whatever are followed by inflammation, if the patient survive their effects long enough, as well as by more or less effusion of lymph; that some structures take on this action more readily than others; that inflammation is often slight in one part and severe in another; and that lymph, when no longer of any use, is invariably absorbed, nature abhorring a substance which she does not need, as in the case of a wound after the completion of the solidifying process; I conceive it to be impossible for any wound, however induced, situated, or treated, to heal by immediate union, or without the intervention of a certain degree of inflammation and more or less deposit of lymph.

The only case, it appears to me, in which such a mode of union would be at all likely to occur, is where the edges of the wound, as, for instance, one of the hand, are carefully approximated immediately after the receipt of the injury, thus affording the vessels and other structures an opportunity of promptly regaining by their homogeneity their natural relations. But even here it is more rational to conclude that the vessels, irritated and fretted by the injury which they have sustained, would furnish a thin film of lymph, serving as a bond of union between the divided parts.

The second mode in which a wound is supposed to be capable of healing is by *scabbing*, and here, also, the cure, it is alleged, is effected without the intervention of inflammation, or a deposit of plastic matter. The blood, coagulating upon the surface of the wound, soon forms a hard, solid crust, which thus protects it from the contact of the air and other injurious influences until it is covered with new skin, when nature's shield, now no longer required, is cast off as an effete substance. This mode of healing is rare in man, but sufficiently common in the inferior animals, as the horse and cow, which are so much less liable to active inflammation and its consequences. It is occasionally imitated by the surgeon's dressing, consisting of lint dipped in blood, or smeared over with collodion, so as to protect the raw surface from the contact of air and dirt. The principal proof of this mode of cure rests upon the assumption that any inflammatory deposits occurring in a case of this kind would effectually destroy the process by prematurely detaching the scab, and so leading to the development of granulations, or union by the second intention. There is, however, no positive evidence that this is the fact, and to my mind the whole theory is a mere speculation, unsupported by a single proof. The difference between such a wound and an ordinary open one is simply this, that, while in the former there is very little inflammation, in the latter there is a good deal, but in neither is it wholly absent.

With regard to the third mode of cure, or union by *adhesive inflammation*, all pathologists are agreed. The only conditions which it demands for its speedy and successful accomplishment are, first, that no coagulated blood shall intervene between the contiguous surfaces, and, secondly, that the part and system shall be maintained in such a state as to keep the inflammation strictly within the limits of healthy lymphization. According to this doctrine, union cannot take place without more or less inflammation and the effusion of a certain amount of plastic matter, serving as a bond of connection between the opposed surfaces, glazing and gluing them together, and ultimately, after having enjoyed the properties of nucleated blastema, assuming the character of connective tissue. Now, if the above views be correct, it follows that all union is the result of adhesive action; that is, of a certain degree of inflammation just sufficient, and no more, to supply the requisite amount of lymph for effecting the cohesion of the raw surfaces. If the quantity of this substance is very small, or its vitality is greatly impaired, no union can occur; nor will such an event take place if the effusion be attended with high excitement; for then the material that is poured out will either be aplastic or it will be converted into pus, thus causing the parts to gape and compelling them to heal by granulation, or union by the second intention. In the more favorable cases of adhesive inflammation, the intervening substance is soon removed by absorption, without being transformed into fibrous tissue, which can only be needed when the union is tardy, or when it is effected through the medium of an inordinate quantity of plastic material; when, in short, the apposition has been somewhat imperfect, and yet not so unfavorable as to offer any serious obstacle to cohesion, or to cause suppuration. When the process of reunion goes on kindly, the merest conceivable film of lymph is generally sufficient; the vessels, nerves, and absorbents rapidly extend from one side to the other across the intervening substance, and as soon as coalescence has occurred, and complete interchange has been established, the new

matter, now no longer needed, is speedily removed in the same manner and for the same reason that the callus is removed after the union of a broken bone; nature, as already stated, being averse to the retention of anything that is useless.

The fourth mode according to which wounds may heal is by the *granulating process*, or union by the second intention. This occurs in all cases where the adhesive inflammation is thwarted, whether from defective action, mismanagement, or any other cause whatsoever. The surface of the gaping wound is gradually covered with granulations, by which the cavity is ultimately filled up, cicatrization constituting the last act of the process.

Finally, it is contended that a wound may heal by *secondary adhesion*, as when the granulations covering its surface are closely approximated and held together by appropriate dressings. In this way, as is alleged, an opportunity is afforded these bodies of growing, as it were, into each other, by an interchange of their respective constituents. To my mind, however, this mode of union does not differ, in any respect, from the process which occurs during the development, aggregation, and cohesion of the granulations upon the surface of a suppurating wound or of an ulcer treated in the ordinary manner. In neither case is the coalescence direct, but intermediate, the connecting bond being a thin film of lymph, similar to that interposed between the raw edges of a recent wound.

If what has now been said be true, it necessarily follows that there are only two modes in which wounds unite, long recognized by surgeons, easily comprehended, and in perfect accord with the results of observation and experience. These two modes are, as was previously stated, adhesive inflammation, or union by the first intention, and repair by granulations, or union by the second intention; in other words, there is no form of union without inflammation and lymph; and the only difference in the two processes here mentioned is that in the one the plastic matter serves as a direct bond of connection between the opposed surfaces, while in the other it is converted into a series of elaborately organized bodies which, by their coalescence, ultimately fill up the gap left by the retracted edges of the wound.

A subcutaneous wound heals in the same manner as an open one, only that, as the air is excluded, there is less inflammation and more rapid cell-growth and repair. Suppuration and sloughing are seldom looked for in any of the more simple forms of such a lesion.

SECT. II.—CONTUSIONS.

A contusion is an injury produced by the sudden and forcible contact of a body, as a club or bludgeon, with a blunt surface, attended with an effusion of blood, but not with any wound of the skin, or, if a wound exist, it is so slight as to be hardly appreciable. When the skin is divided, the lesion constitutes what is called a contused wound, or a contused and lacerated one. A contusion may affect any of the structures, superficial as well as deep, hard as well as soft, cutaneous and connective tissues, muscles, nerves, bloodvessels, fibrous membranes, bones, and viscera, presenting itself in various forms and degrees, at one time slight and at another severe, according to circumstances, more especially the violence of the blow and the amount of resistance offered by the parts struck.

The causes of contusions are of a very numerous and diversified character. Among the most common are blows and falls, and machinery in rapid motion. A pinch with the thumb and finger, or a light stroke with a hammer, affords a good illustration of a slight injury of this kind. The effect of long-continued pressure in the production of contusions is well exemplified in what so often occurs in the child's head in laborious parturition, by which the scalp is severely bruised, and more or less blood is extravasated underneath the tendon of the occipito-frontal muscles. From the same cause the vagina often suffers, the bruised structures taking on inflammation, which, in some of the worst cases, terminates in sloughing, and in the establishment of vesico-vaginal fistule. The prostate gland, as every lithotomist knows, is sometimes badly bruised in the extraction of a urinary calculus, either because of its large size, or from the maladroit use of the forceps. A severe contusion may be produced by the mere concussion of an organ, as, for instance, the brain in injuries of the skull, or the testicle in riding on horseback, from the forcible contact of the organ with the saddle

Contusions vary much in degree. In the milder forms there is simply a little discoloration of the surface, or the subcutaneous connective tissue is slightly infiltrated with blood, or a small quantity of blood is collected at a particular spot, all of the unnatural appearances subsiding in a few days, either spontaneously or under the influence of some gently stimulating lotion. In the second degree, as it may be regarded, the lesion is more serious and extensive, there is greater change of texture, a larger quantity of blood is poured out, or

an artery of considerable size is laid open and a diffused aneurism is formed, contusion and laceration of tissue coexisting. In the worst degree, the soft structures are completely disorganized, mashed, or pulpified, and, if life is not speedily destroyed by shock, or shock and hemorrhage, they are soon assailed by mortification. Injuries like these are most commonly produced by falls from a great height, by the passage of the wheel of a carriage, or by the contact of a partially spent cannon ball. The skin in these frightful accidents generally participates in the lesion; but now and then an instance occurs in which, owing to its elasticity, it remains intact, although the underlying structures may be irretrievably damaged. The internal organs, as the liver and spleen, are not unfrequently fatally contused by a blow or a kick, without the faintest trace of injury of the skin where the violence was inflicted. The lungs and the brain occasionally suffer in a similar manner.

Some persons are so peculiarly constituted as to suffer from contusions from the most trivial causes, as the slightest blow, pinch, or pressure, as in sitting on a hard chair, or lying on a hard, uneven mattress. Old, fat, anemic women, with a very lax and delicate skin, are peculiarly liable to suffer in this way, some indeed almost habitually, more especially on the back, arms and thighs. Scurvy, wasting diseases, the hemorrhagic diathesis, and, in fact, all affections attended with an impoverished condition of the blood, may be enumerated as so many predisposing causes of these occurrences.

The shock in contusion is not always in proportion to the gravity of the accident, the degree generally depending more upon constitutional peculiarity than any thing else. In violent cases, as when an important viscus or a large joint has been crushed, it may be so great as to prove fatal, either speedily or after a feeble attempt at reaction.

The effects of contusions are primary and secondary, and in both cases they may be slight or more or less severe, if not fatal. Contusions involving the skin, or the skin and subcutaneous connective tissue, are always attended with a certain degree of discoloration, purplish, black, or reddish at first, but gradually, as the blood causing it disappears, shading off into bluish, olive, greenish, or brownish yellow, until it finally vanishes. When the blood is situated among the muscles, the discoloration may not show itself for several days, and even then it does not always appear at the part hurt, but perhaps at a considerable distance from it, the fluid gravitating along the easiest route towards the surface.

In nearly all contusions there is more or less swelling, the degree being usually in proportion to the degree of violence, the nature of the affected structures, as their laxity or density, and the amount of extravasated blood. Its advent, as well as its departure, may be sudden or gradual. In the former case it may be due solely to effusion of blood, but generally there is, in addition to the blood, a rapid exudation of serum, or of serum and fibrin, and also great distension of the vessels, the whole contributing to the formation of what is vulgarly called a bump, so common about children's heads as an effect of blows and falls. When the swelling is slow, it is usually attributable, especially in the absence of inflammation, to the gradual accumulation of blood, in consequence of the rupture of the injured vessels under the pressure of their contents. There is no doubt, however, in all such cases more or less exudation.

The contused structures have generally a feeling of numbness, especially if largely supplied with nerves. When the injury is slight, the sensation is commonly very transient; but now and then it lasts indefinitely, and is a source of intense suffering, as is so often witnessed in contusions of the scalp, tibia, knee-joint, spine, and shoulder. Partial and even complete paralysis and loss of sensation may exist when a large nervous trunk is severely contused.

The pain consequent upon contusions is usually very slight and evanescent, passing off soon after the receipt of the injury. It is only in exceptional cases that it is at all severe in the first instance. As a secondary effect it is sometimes very troublesome, especially in contusions of the back of the head, often assuming a neuralgic character, increased by pressure, atmospheric vicissitudes, and disorder of the general system, and liable to periodical exacerbations. A contused joint, eyeball, and bone are frequently the seat of severe local distress long after the occurrence of the primary lesion.

The amount of blood effused in this accident may be very slight, on the one hand, or very copious, on the other, depending as already stated, upon the extent of the vascular involvement and the laxity or firmness of the connective tissue. In the milder forms of contusion the blood stagnates in the capillary vessels of the skin, or is effused into the connective tissue below, so as to cause merely a little discoloration of the surface, discoloration as is witnessed, for example, in a bruise of the scalp or in the " black eye " of the pugilist, from a blow of the fist. The effused blood generally occurs as an infiltration being more or less widely diffused through the connective tissue, where it is speedily brought

under the influence of the absorbents, and in a very short time completely removed, a few days often sufficing for the purpose. What is called an *ecchymosis* so often found in contusions, consists essentially in a slight extravasation of blood, caused generally by the rupture of the smaller vessels, situated in the connective tissue, immediately beneath the skin, and presenting itself in the form of a livid, black, deep blue, or purple spot, of irregular shape and variable size. It generally comes on immediately or within a short time after the infliction of the injury, and is usually superficial, although it may be deep-seated, affecting the interior of a muscle, a bone, or a viscus. Numerous ecchymoses are occasionally found in the brain, lung, spleen, and liver, after accidents, in which the parenchymatous structure of these organs has been more or less severely bruised. When, in consequence of an injury, the blood is collected in a small circumscribed spot, the affection takes the name of " thrombus," while the term " depot" is employed to designate it when it is large and concentrated. The accumulations of blood which occur on the child's head, and in the labium of the mother, during severe and protracted labor, are good illustrations of a sanguineous depot, so often met with upon a large scale in severe contusions, both with and without any external wound. When the extravasation is copious, it is presumable, whatever may be its form, that it has been caused by the rupture of some of the larger vessels, and such an occurrence should, therefore, always be regarded as one of a serious character, often placing limb and life in jeopardy.

The presence of blood in the contused structures, whether occurring as an ecchymosis, a thrombus, or a depot, is denoted by discoloration of the skin, and by a marked sense of fluctuation, some parts of the swelling, however, generally feeling harder than others, depending upon the manner in which the blood is bound down by the overlying tissues. When an artery of considerable size has been laid open, there will be, in addition to these phenomena, more or less pulsation and murmur, or that peculiar whirring sound so characteristic of aneurism.

The extravasated blood, in contusions, may be perfectly fluid, semifluid, or solid, the consistence depending upon the amount of injury sustained by the parts. When the injury has been very severe, the blood may be completely devitalized, and then it will of course be perfectly fluid, as, for example, not unfrequently happens in the accumulations that occur upon the child's head in difficult and protracted labor; very generally, however, it is partially, if not completely, coagulated, and it need hardly be added, what indeed is self-evident, that the condition of the blood greatly influences its own ultimate disposition, as well as the effects induced by it upon the tissues in which it is located. When it retains its vitality, and the quantity is inconsiderable, it is usually speedily absorbed, or, even if it remain for some time, it is not likely to excite any mischief. When, on the contrary, the blood is necrosed, it is either not absorbed, or it is soon decomposed and thus becomes a source of irritation and inflammation, leading, not unfrequently, to suppuration, ulceration, or even mortification, the more especially if the soft parts have been much contused, or if they are severely compressed by the extravasated fluid. When the blood is very abundant, it may, even if it retain its vitality, so oppress and choke the absorbent vessels as to incapacitate them for its removal, just as sometimes happens in large dropsical effusions. Occasionally the blood separates into its two constituent elements of serum and crassamentum. The opinion that this fluid, in favorable conditions of the part and system, may become vascularized, and gradually transformed into connective tissue, is generally admitted by pathologists, although such an occurrence must necessarily be uncommon and exceptional. Whether the new growth, as it may under such circumstances be regarded, occasionally forms the starting-point of various kinds of tumors, innocent and malignant, is not determined, greatly as the question has been agitated.

The more severe forms of contusion are occasionally followed by more or less effusion of pure serum, unaccompanied, apparently, by any fibrin and hematin. The occurrence is most common in injuries in which the skin is forcibly torn from the subcutaneous connective tissue, especially when it is detached obliquely, as when the wheel of a carriage passes over a limb, severely bruising the soft structures without causing an open wound. The ruptured capillary vessels in such a condition readily part with their serous contents, while the more solid portions of the blood are retained, the quantity poured out varying from a few drachms to several ounces. The ordinary site of the effusion is the subcutaneous connective tissue, but, at times, it is also found in the intermuscular. The fluid appears either as a circumscribed, globular tumor, soft and fluctuating, or, as is more commonly the case, as a veritable extravasation, vague, undefined, and undistinguishable from an ordinary accumulation of blood under the skin, excepting that there is, perhaps, less

discoloration of the surface. In chronic cases, the fluid is sometimes distinctly encysted. In its color the fluid, at first, is generally somewhat reddish, but it gradually assumes a pale amber hue, and eventually becomes perfectly clear and limpid ; it is viscid to the touch, saline in taste, and coagulable by heat and acids.

A contusion may be dangerous or otherwise, according to its extent, the nature of the parts involved, and the state of the constitution. A slight bruise in a person in ill health at the time of its occurrence, may become a source of great suffering, even when the structures affected are not at all important to life, from the supervention of suppurative inflammation, ulceration, or gangrene. A severe contusion of an internal organ, as the spleen or liver, may prove speedily, if not instantly, fatal. A contusion of the scalp may cause erysipelas, phlebitis, abscess of the brain, pyemia, and death. Old men not unfrequently perish from injuries of this kind inflicted upon the prostate gland in lithotomy and lithotrity. A contusion complicated with the laceration of important vessels and nerves, the crushing of bones, and the perforation of the larger joints, is always a dangerous occurrence. Limb and life are sometimes imperilled secondarily, as when there is a large accumulation of blood, rapidly undergoing devitalization and putrefactive decomposition, poisoning the system by the imbibition of noxious gases and ichorous matter. The prognosis is unfavorable in severe contusions occurring in persons exhausted by scurvy, anemia, typhoid fever, and long-continued and profuse discharges.

In the *treatment* of contusions the leading indications are, to prevent further effusion, to limit inflammation, and to promote the removal of the accumulated blood.

In the lighter forms of injury the application of cold water, simple or medicated, will generally be all that is required for a speedy cure. Lotions of arnica, vinegar, and common salt, lead, Goulard's extract, chloride of ammonium, alum, and spirit of camphor are among the most important agents in this class of injuries, most of them acting as powerful sorbefacients, at the same time that they tend to repress excitement and prevent effusion. Pounded ice, inclosed in a bladder or rubber bag, spread out over the affected surface, is often a very valuable remedy, but is not to be used without proper vigilance, lest it should harm by depressing the vital powers of the part. Leeches may be scattered over the affected surface when there is much local disorder. Cataplasms and warm water-dressing are sometimes serviceable. The most trustworthy sorbefacient is a strong solution of chloride of ammonium, with the addition of a small quantity of vinegar, applied upon folded flannel, covered with oiled silk, and renewed six or eight times in the twenty-four hours. Parts excessively contused generally require stimulating applications, as alcohol and water, or lotions of spirit of camphor, not, of course, too long continued.

When the blood is devitalized, or in a decomposed condition, whether fluid or coagulated, it should be promptly evacuated by a free incision, the abnormal cavity being well washed out immediately after with tepid water, impregnated with permanganate of potassium, or, with a few drops of any of the acids. Undue reaction is controlled with morphia, while the treatment, in other respects, is managed upon general principles. When the cavity left by the discharge of the effused blood is very large, reunion will be promoted by the use of the compress and roller. Diffused aneurism is treated by exposure of the wound, and by the ligation of both ends of the affected artery. Amputation may become necessary when the contusion occupies an extremity, and is attended with extensive pulpification of the soft tissues, crushing of the bones, laceration of important vessels and nerves, and the penetration of the larger joints. The treatment of the secondary effects of contusions will receive proper attention in connection with the diseases and injuries of the different organs and textures.

Cavalry-men and grooms are exposed to a severe form of contusion of the tibia, from the kick of the horse. The accident is liable to be followed by violent inflammation, with a tendency to erysipelas and diffused abscess. Recovery is often slow, and suffering great, especially if there has been much concussion of the bone, or extensive injury of the periosteum. The treatment is conducted upon general principles, with the addition of free incisions to liberate the soft parts, the knife grating against the surface of the bone, as in the operation for whitlow.

Tissues that are firmly compressed, constricted, or strangulated are placed very much in the condition of contused structures, and are liable, if not promptly rescued, to become severely, if not fatally, constricted. A bandage tightly wound around an inflamed limb may give rise to gangrene ; a ring slipped over the wrong finger, to violent inflammation ; and the narrow aperture through which the intestine descends in a recent hernia, to mortification of the protruded structures. Paraphimosis affords a good illustration of the

compression and contusion of a part by the action of the common integument, the effect being similar to that produced by the pressure of a tight ligature. The first effect of such an occurrence is an impediment in the vessels and nerves, interfering with the circulation of the blood and the transmission of nerve fluid, speedily followed by an effusion of serum, giving rise to a soft, glossy, œdematous condition. If prompt relief be not afforded, the obstruction increases, inflammation is set up, lymph is poured out, the circulation is completely suspended, and the parts, assuming a dark, mottled, purplish, or blackish hue, are irretrievably lost. These effects often ensue in an almost incredibly short time, as, for example, is so often witnessed in strangulated hernia, especially in cases of recent standing accompanied with an unusually small aperture of descent.

The treatment of these and similar affections is sufficiently obvious, the first and most important point being the removal of the exciting cause, after which an attempt must be made to repair any damage that may have been done by the constriction, special pains being taken to restore the circulation and to promote the absorption of inflammatory deposits.

SECT. III.—INCISED WOUNDS.

Incised wounds are simple cuts made with any sharp instrument, as a knife, a sword, or an axe, and vary in extent from the slighest possible incision to a gap of frightful length and depth. The largest incised wounds are usually made designedly by the surgeon in the extirpation of tumors, in the amputation of the limbs, and in the resection of the joints. In general, they are open, and therefore in contact with the air; sometimes, however, they are subcutaneous, and therefore exempt from such exposure. All incised wounds, however simple, are characterized by three phenomena, deserving of special consideration : 1st, hemorrhage ; 2dly, more or less pain ; and 3dly, retraction of the edges of the divided structures.

1st. The hemorrhage varies in quantity, from a few drops to several ounces, or even quarts, according to the extent of the injury, and, above all, the vascularity of the affected tissues. When the capillaries alone are involved, the blood oozes rather than flows away, the reverse being the case when a tolerably large vessel is divided. The hemorrhage may be strictly arterial, but generally it is both arterial and venous. In the former case the fluid is of a scarlet color, and spirts out in jets, synchronously with the contraction of the heart ; in the latter, on the contrary, it is of a dark modena, or purple complexion, and issues in a continuous stream, as in bleeding at the arm. Some structures are naturally more vascular than others, and, therefore, yield more blood when divided. Thus, a wound of the lip bleeds more freely than one of the cheek, and of the cheek than one of the leg. Again, a part that is habitually irritated bleeds, when divided, much more copiously than when it is in a healthy state. A familiar example of this occurrence is afforded in excision of the tonsils, an operation which is sometimes attended with profuse hemorrhage, in consequence simply of the enlargement of the vessels, and their inability to retract on account of inflammatory effusions.

2dly. The pain, like the hemorrhage, attendant on an incised wound, is influenced in its extent by the size of the lesion, the nature of the affected textures, and the temperament of the individual. In general, it very soon subsides, and does not afterwards return, unless there is undue inflammatory action. When a large nerve is implicated in the injury, there is usually, in addition, some degree of numbness in the surrounding tissues, and occasionally, also, partial paralysis in the distal parts.

3dly. The retraction of the edges of the wound is dependent upon the natural resiliency of the cutaneous and muscular tissues. It is very materially influenced, however, in its degree, by the depth of the wound, by its situation, and also by the amount of motion to which it may be subjected immediately after the receipt of the injury. Thus, a wound of the hairy scalp, extending down to the bone, will hardly gape any, while one on the forehead, arm, or leg will exhibit a frightful cavity ; in the one in consequence simply of the muscular contraction of the part, and in the other of the change of posture.

The *treatment* of such an injury is perfectly simple. The first object is to arrest the hemorrhage, provided this has not been already done by the natural efforts. When it is strictly capillary, it will either soon cease spontaneously, or it may readily be checked by exposing the wound to the air, or by pressing upon it a sponge wet with hot water. When, on the other hand, it proceeds from a vessel of considerable size, the more prudent course will be at once to apply a ligature ; for, although it may be temporarily arrested, it will be very liable to break out again, if not upon the slightest exertion, at all events,

so soon as reaction is fully established, and it may then become a source of great annoyance both to the patient and to the surgeon.

The hemorrhage having been arrested, all foreign substances, however delicate or minute, must be carefully picked away with the forceps, removed with the fingers, or dislodged with a stream of water, squeezed from a sponge, or thrown upon it from a syringe. The finest hair, if allowed to remain, would act as an irritant, and impede the adhesive process. The same remark is applicable to any blood that may cover the wound or incrust its edges. It is just as necessary to remove this as dirt or any extraneous substance whatever. Even the slightest possible layer of blood is likely to prove a barrier to immediate reunion; for, although this fluid sometimes is unquestionably susceptible of organization, such an event is never expected or wished for under such circumstances. Hence the whole surface of the wound should be thoroughly freed of it, not roughly, of course, but as gently as possible, before an attempt is made to approximate its edges. If the blood is coagulated and adherent, it may readily be detached with the fingers, forceps, or handle of the scalpel. Finally, the circumjacent parts, if covered with hair, are carefully shaved and washed.

The object of these preliminaries is to place the wound in the most favorable condition for union by the first intention, or the establishment of the adhesive process. To insure this, the edges must be carefully approximated in their entire extent, and retained in contact for a certain period, by appropriate means, aided by rest and proper position of the part. If the wound is of small extent, nothing will be required beyond a strip or two of adhesive plaster. If, on the other hand, it is long and deep, it will probably be necessary to use, in addition, a few sutures, if not, also, a compress and bandage.

The wound being dressed, and the parts concerned placed at rest in a relaxed, and, if possible, also, in an elevated position, little remains to be done by the surgeon, except to watch and assist nature in her reparative efforts. Within a short time after the edges of the wound have been approximated, inflammation is set up, speedily followed by an effusion of plasma, not only upon their surface, but also into the surrounding tissues. The interposed layer, perhaps hardly as thick as the most delicate spider's web, soon becomes organized, by an interchange of vessels and nerves between the opposite sides, is converted into connective tissue, and thus forms a bond of union between the divided structures. In the meanwhile the inflammation gradually subsides, the surrounding tissues regain their accustomed functions, and the consolidation is completely established. The resulting cicatrice remains rough for some time, but by degrees it becomes polished, and finally assimilates itself to the natural skin, except that it is whiter, destitute of hair, sebaceous follicles, and sweat glands, and less capable of resisting the effects of disease and injury.

But it is not always that the healing process advances so favorably as it is here described. Very frequently, indeed, it is materially retarded, interrupted, or even entirely subverted. Of the various causes which may contribute to bring about this untoward result, the most common are the presence of foreign matter in the wound, want of accurate apposition, too much motion, improper applications, or undue inflammation, however induced. It is, therefore, the duty of the practitioner not only to attend well to every case of this kind in the first instance, but to watch it most sedulously throughout its entire progress, inciting action when it is deficient, and repressing it when it is too high.

If the symptoms assume an untoward tendency, the adhesive action threatening to pass into the suppurative, the sutures and plasters should immediately be slackened, and water-dressing, either warm or cold, simple or medicated, applied, according to the tolerance of the part and system. In general, simple water will be found to answer better than anything else, and may often be advantageously employed from the very commencement, especially if the wound is very large, in anticipation of inordinate action. The diet, bowels, and secretions must be properly regulated; and, if suppuration be inevitable, the most agreeable and soothing remedy will commonly be a light, emollient cataplasm. Gaping of the wound should be counteracted by the use of adhesive strips, aided by position, and, if necessary, by a few loose stitches and the bandage.

SECT. IV.—SUBCUTANEOUS WOUNDS.

Subcutaneous wounds differ from all other wounds in three important particulars: first, they do not have an exposed surface, or, in other words, the tissues that are involved in them are not laid bare; secondly, they are generally followed by very slight inflammatory action; and, lastly, they heal, for the most part, promptly, by union by the first intention,

the whole process of repair being one of unusual rapidity, evidently due to the fact that no air is admitted into them to embarrass the cure. It is upon a knowledge of these principles that Stromeyer and his followers founded what is now known as subcutaneous surgery, a branch of practice which is of such signal service in the treatment of malformations and deformities.

There are, properly speaking, two varieties of subcutaneous wounds, sufficiently distinct in their character to entitle them to separate consideration. In one, that to which the above remarks are chiefly applicable, the wound communicates with the exterior, the aperture by which this is effected being usually a mere puncture, such, for example, as is made in tenotomy, or in the subcutaneous division of a tendon; in the other, which is often a formidable lesion, the skin is not perforated, and, consequently, there is no admission of air, not even transiently. Such wounds are essentially contused and lacerated wounds, in which, even occasionally when the lesion is of the most formidable character, the integument either retains its integrity, or, as more commonly happens, it is somewhat bruised, cut, or torn, but not completely divided. A simple fracture is essentially a subcutaneous wound of a bone and of the adjacent soft structures. A wound made by the tearing away of a tendon from a muscle, leaving behind its sheath, is a lesion of a similar kind. Thus, it will be perceived that, although in one of these wounds air is admitted, and in the other excluded, yet the former is by far the more simple of the two, seldom much inflamed, and generally easily healed.

The subcutaneous wound most commonly met with is that so often made in tenotomy and in kindred operations practised for the rectification of various affections of the muscles, aponeuroses, ligaments, and other structures, and which, in its character, combines the puncture with the cut. Lesions of this kind have been studied chiefly in connection with tenotomy, and I shall, therefore, limit myself, in great measure, in what I intend to say upon the subject of subcutaneous wounds, to what occurs in a divided tendon.

In tenotomy, the skin, generally pierced somewhat obliquely, is opened just sufficiently to admit of the easy introduction of the knife used for the division of the tendon. The moment this is effected, the ends of the cord acted upon by the muscle with which it is connected retract, thus leaving a gap of variable extent between them. The little puncture in the skin being immediately closed with adhesive plaster, the parts are placed precisely in the same condition as in a wound originally without an external opening. The air that always enters such a wound is speedily absorbed; the effused blood, too, soon disappears, and nature, ever on the alert in such a case, rapidly fills up the gap with plasma. Some inflammation necessarily ensues, but the action is slight, and in no wise hostile to repair, or to the development of new tissue. The plasma, at first soft and jelly-like, and of a ruddy tinge from the intermingling of hematin, the result of the knife's work, gradually augments in firmness, and presently assumes a grayish or whitish appearance. Proliferation and growth are active, but the cells rarely advance beyond the fusiform, and often, at an early period, manifest a retrograde movement, degenerating and atrophying. The surrounding tissues always participate in the inflammatory action, becoming red, injected, slightly swollen, more or less tender, and infiltrated with bloodliquor. The new piece of tendon, when fully developed, is found to bear so close a resemblance to the primitive as to be with difficulty distinguished from it; it fills exactly the original gap, and thus forms a continuous structure, slightly overlapping and ensheathing the retracted extremities, and soldering them firmly together, much after the fashion of the ensheathing callus in a broken bone. As the process approaches completion, the neighboring structures gradually return to their normal condition, their vascularity disappearing, the inflammatory material being cleared away, and eventually function being completely restored.

What occurs in a subcutaneous wound after the division of a tendon happens, under similar circumstances, in other structures; the new connecting bond, however, is not always precisely like the original, especially in muscle and cartilage; and the retraction of the divided ends is generally much less than in tendon. Thus, in the connective and adipose tissues, in nerves, ligaments, and fibrous membranes, it is hardly perceptible unless the parts are forcibly stretched during or immediately after the division.

In the second class of subcutaneous wounds, the risk to limb and life forms in many cases a most important element; for, although there is originally no external opening admitting air, yet the injury inflicted upon the affected tissues is frequently so severe and extensive as to be followed, perhaps, in a very short time, by the most disastrous consequences, death being often caused by shock, gangrene, or diffused suppurative inflammation, blood and solids being alike depressed, if not more or less devitalized. The skin,

without being cut or pierced, is often extensively detached from the connective tissue beneath, and is, therefore, in imminent danger of sloughing from the arrest of its circulation. In their character such wounds are essentially bad forms of contused and lacerated wounds. The more simple forms frequently admit of cure, although the structures concerned in them generally remain long in a weak and crippled condition. The reparative process is similar to that of an incised subcutaneous wound, that is, the effused blood is generally carried away, and the plasma that is poured out serves to connect the ends of the divided structures; all redundant substance eventually disappearing, and the parts, if not too much injured, resuming their normal functions. The reason why a simple fracture heals so much more readily than a compound one is that in the one the air is excluded, and in the other admitted. The treatment of open wounds, of whatever character, is often greatly expedited by the employment of protective measures, not too frequently changed. The much vaunted antiseptic treatment owes, I have no doubt, more of its efficacy to this circumstance than to any special virtue of the antiseptic agents themselves.

The treatment of a subcutaneous wound is generally of the most simple kind, perfect rest and elevation of the affected parts constituting the most important elements of success. If the inflammation threatens to transcend the limit of fibrinous exudation, the case must be met by the application of leeches, medicated lotions, the cold water-dressing, or emollient cataplasms, along with appropriate internal remedies. The treatment of contused and lacerated subcutaneous wounds does not differ from that necessary in open wounds of this character, described in a previous section.

SECT. V.—LACERATED WOUNDS.

A lacerated wound is a lesion in which the tissues, instead of being smoothly divided with a sharp, cutting instrument, are torn rudely and forcibly asunder. The edges are ragged and irregular, there is little pain or hemorrhage, and the surrounding parts, frequently bruised and discolored, are cold and numb. The injury most commonly occurs in factories, grist-mills, and steamboats, from the clothes and limbs being accidentally caught in the machinery. Extensive lacerations are often caused by weapons of war; by the teeth of the inferior animals, as the shark, dog, and bear; by the passage of the wheel of a cart or carriage; and by falls from a considerable height, in which the body strikes against a hard and projecting object, as a stone, post, or railing.

A lacerated wound differs from an incised one, 1st, in the slightness of the attendant pain; 2dly, in its indisposition to bleed; 3dly, in its tendency to suppurate and slough; and, 4thly, in its liability to be followed by erysipelas, septicemia, pyemia, tetanus, and other nervous symptoms.

The pain in lacerated wounds is generally very trifling; indeed, instances are frequently met with in which there is no pain at all, the patient being unconscious not only at the moment, but for some time afterwards, of having received any serious injury. Thus in the case of Wood, the miller, as detailed by Cheselden, the arm was torn off at the shoulder, and yet so slight was the pain that the man was not aware of what had occurred until he observed the limb moving round on the wheel. I have seen instances in which the tendons of the fingers, along with portions of their muscular bellies, were pulled out with such velocity that the patient not only experienced no pain, but was for some time utterly unconscious of the injury. When the lesion is very grave and extensive, as when a limb is suddenly severed from the trunk, the attendant shock must necessarily be so severe as, in great measure, to obliterate all local sensation. Upon the occurrence of reaction, however, the pain is frequently intense.

The absence of hemorrhage in a lacerated wound forms a very striking feature, and is the direct consequence of injury done to the vessels. In an incised wound there is no impediment to the flow of blood, because the vessels are divided evenly; in a lacerated one, on the contrary, they are torn into shreds and fragments, which readily intercept the fluid as it sweeps over them, and thus promote the formation of a coagulum, often extending high up into the tube. The vessels, moreover, are partially paralyzed, from the injury sustained by the nervous filaments of the affected parts; hence they are incapable of contracting upon and propelling their contents. In addition to these circumstances, there is frequently, especially in severe lacerations, excessive prostration of the system, which powerfully contributes to the coagulation of the blood, and to the formation of an internal clot. This indisposition to hemorrhage is often present even when very large vessels are wounded. In the celebrated case of Wood, above alluded to, the arm was torn off along with the scapula, and yet there was no hemorrhage. A number of instances of a similar

kind have been published, among the more remarkable of which are those related by La Motte, Morand, Clough, Mussey, Scarnell, Lizars, Braithwaite, Cooper, King, and Lowe.

Lacerated wounds are frequently deceptive in their appearance, the amount of injury being much greater than the surgeon is at first sight led to suppose. The skin, for example, may be affected very slightly, perhaps, indeed, hardly at all, while the muscles, aponeuroses, vessels, and even the nerves, may be extensively severed, or torn up. In many cases the bones are crushed, large joints laid open, and the soft structures completely pulpified. Hence too much caution cannot be observed in our examinations, as well as in our prognosis.

The *treatment* of a lacerated wound is conducted upon the same general principles as that of an incised one. All extraneous matter is removed, the vessels, if necessary, are tied, the parts are neatly approximated, and every precaution is used to moderate the resulting inflammation. In applying the ligature, a sound portion of artery is selected, otherwise secondary hemorrhage will almost with certainty follow the sloughing process. When the hemorrhage is venous, it may generally be promptly and effectually arrested by a compress and roller, so arranged as not to impede the return of the blood to the heart. All undue constriction must be avoided. Ligation is rarely called for, even when the largest veins are torn across. Although it is not probable, from the ragged character of the wound, that much of it will heal by the adhesive process, it is always best to treat the case with reference to this object. For this purpose the edges, after having been neatly trimmed, are lightly approximated, and maintained by adhesive strips, supported by a bandage; all tension is carefully avoided; and large interspaces are left between the plasters for easy drainage. Sutures may usually be dispensed with, although I have not the same dread of them that some surgeons have; for while I have, in many cases, derived the most signal benefit from their employment, I have never seen them do any harm. Any parts that are completely devitalized may at once be cut away, but as there must generally be some doubt on the subject, it is a good rule to let them alone, and intrust their separation to the efforts of nature; or, at any rate, to wait until it is perfectly certain that they are dead.

To moderate the inflammation, water-dressing is used, either warm or cold, as may best comport with the comfort of the patient. On the appearance of suppuration it may, unless it is acting very kindly, give way to an emollient cataplasm, which, in its turn, is superseded as soon as the granulating process is fairly established, by opiate cerate, or the dilute ointment of nitrate of mercury. If the inflammation run very high, threatening to terminate in gangrene, purgatives and nauseants are freely used, and leeches are applied to the parts immediately around the wound. The lancet is rarely required, except in very robust and plethoric subjects, in whom, under such circumstances, it cannot be resorted to too early or hardly too vigorously. The mercury is frequently indicated at the very commencement of the treatment, on account of the concomitant derangement of the biliary and digestive apparatus, produced by the shock of the injury. It should be administered in moderate doses, either alone or conjointly with opium, Dover's powder, or morphia and antimony. Anodynes must be freely given to allay pain and insure sleep. Much judgment is required not to carry the depletion too far. Due allowance must always be made for the waste which must necessarily attend a wound of this description, as well as for the depression which the system experiences in the first instance, and which often continues to exert its baneful influence for days and weeks together.

Attention was called, in 1874, by Dr. F. H. Hamilton, to the treatment of wounds by immersion in simple warm water; and Dr. David Prince, of Illinois, had previously employed what he calls "perpetual irrigation" with warm water impregnated with $\frac{1}{1000}$ solution of carbolic acid and $\frac{6}{1000}$ of salicylic acid. The treatment is especially commended in lacerated wounds and in wounds attendant upon compound fractures and dislocations; it is generally very soothing in its effects, lessens suppuration, promotes cleanliness, and conduces in many cases, cases even of an apparently desperate nature, to recovery. I have no personal experience with this method of treatment, but have great faith in the judgment of the two able surgeons who so highly recommend it.

Secondary hemorrhage in such a wound may arise as soon as reaction takes place, or it may be postponed until the sloughs begin to separate. In the latter case it will not be likely to occur before the fifth or sixth day. When there is reason to expect such an event, as when an artery of considerable size is implicated, the patient should be most sedulously watched until the crisis is past, a tourniquet being placed loosely around the limb, and the nurse instructed in its use, so as to be fully prepared to meet the emergency

the moment it arises. For the want of such precaution, life might be destroyed in a few minutes, before it is possible for the attendant to reach the bedside.

Tetanus, as the result of a lacerated wound, is most frequently met with in nervous, irritable subjects, during the prevalence of hot, or damp, chilly weather, and often arises without any obvious cause, either as it respects the injured part or the system. Anodynes, especially morphia and chloral in large doses, will sometimes promptly arrest it in its earlier stages, but when fully developed it almost always proves fatal, whatever may be the nature of the treatment.

When the laceration is seated in an extremity and involves important vessels and nerves, or when it is accompanied by a comminuted fracture, a compound dislocation, or a disorganized state of the soft parts, amputation will probably be required, the proper period for its performance being the moment reaction is fully established. If it be undertaken while the patient is pale, faint, and exhausted, he will almost certainly die from the shock of the operation, either immediately, or, at most, within a few hours after. On the other hand, amputation must not be postponed until the system has been assailed by inflammation, since this would equally compromise the result. The time, then, for interfering is when the heart has, in some degree, resumed its wonted action, the pulse reappeared at the wrist, the color returned to the face, and the warmth been reëstablished in the extremities ; then, but not until then, is the use of the knife proper.

SECT. VI.—CONTUSED WOUNDS.

A contused wound derives its chief characteristics from the compressed and disorganized condition of the tissues, and occurs in two varieties of form, the open and the subcutaneous, the integument in the latter retaining its integrity, whereas in the former it is more or less cut or lacerated. The injury, in either event, may arise in a great many ways, as from a blow with a heavy bludgeon, the kick of a horse, the passage of the wheel of a carriage, the contact of a partially spent ball, or the explosion of a gun, shell, or rocket. An ugly contused wound is occasionally received in a high fall, in which the person alights among sharp and disjointed stones, upon a pile of timber, or upon a mass of rubbish. The most severe accident, however, of this kind, is that which follows the passage of the wheel of a railway car, in which the body is most frightfully mangled, the soft parts being literally pulpified and the bones ground in pieces. The contusion and laceration which occur under the scalp during the descent of the child's head in parturition afford a good illustration of a subcutaneous contused wound.

The effects of a contused wound are various. When the injury is very severe, life may be destroyed on the spot, precisely as in a gunshot wound, from shock or loss of blood, without any attempt whatever at reaction. In the milder forms, however, the consequences may be very trifling. From the manner in which the structures are bruised, there is generally but little pain both in the first instance and for some time afterwards ; the part feels merely stiff and numb, perhaps somewhat sore and tender ; by and by, however, when inflammation arises, the pain is often considerable, and in some instances it is even extremely severe. When the injury is extensive, there is always violent shock ; the patient is deadly pale and almost bereft of consciousness, the pulse is hardly perceptible, and there is great coldness of the extremities. When he recovers from this state, he is apt to suffer from vomiting and various nervous disorders. If the weather be hot, or the constitution unusually irritable, he may be seized with locked jaw. Neuralgia is also liable to occur as a sequel of such accidents.

Another peculiarity of the contused wound is the trivial hemorrhage which usually attends it ; resembling, in this particular, the lacerated and punctured wound. The vessels being bruised and paralyzed, are unable to propel their contents, which, consequently, almost instantly coagulate, thus opposing an effectual barrier to the effusion of blood, which is also, at the same time, in many cases, if not generally, deprived of its vitality in the midst of the injured and perhaps pulpified tissues. When, however, the lesion is very slight, the vessel always throws out more or less blood, although the flow is never copious, except when an artery of considerable size has been laid open, when it may be so great as to prove speedily fatal. Much, then, will depend, in every instance, so far as bleeding is concerned, upon the extent and the particular character of the lesion sustained by the coats of the vessels, and also, but in a minor degree, upon the injury inflicted upon the blood itself.

Although there frequently is little or no bleeding in such a wound immediately after its occurrence, there is generally, if the injury be at all extensive, great danger of secondary

hemorrhage.   The period at which this will be most likely to arise is when the sloughs begin to separate, which, on an average, will be from the fifth to the tenth day, according to the size of the breach and the amount of the concomitant contusion.   Hence, as in lacerated and gunshot lesions, the patient should always be diligently watched during this time, lest, hemorrhage coming on unexpectedly, he should perish before proper assistance can be obtained.

Contused wounds seldom heal, even in any considerable degree, by union by the first intention ; the vessels are too much crippled to furnish healthy plasma ; and the inflammation is often so violent that the surgeon is extremely fortunate if he can restrain it within suppurative limits.   Gangrene is by no means uncommon, the more especially if the lesion be at all severe ; for there are few cases in which more or less tissue is not devitalized during the infliction of the injury, and, under such circumstances, more or less sloughing is of course inevitable.   Large abscesses often follow, particularly in contusions of the scalp, the hands and feet, the walls of the abdomen, the perineum, and the muscles of the thigh, back, and shoulders, the matter being not unfrequently extensively diffused among the surrounding structures, and preceded in its development by erysipelatous inflammation, a nervous, irritable, and exhausted state of the system generally powerfully predisposing to the untoward occurrence.

Serious injury is occasionally inflicted upon the trunk or upon a limb, without any outward evidence whatever of the fact, perhaps not even the slightest bruise, scratch, or discoloration of the surface.   Such accidents are most frequently caused by the passage of the wheel of a carriage, the kick of a horse, machinery in rapid motion, or the blow of a cannon ball, and are easily accounted for by the elasticity of the skin, which enables it to glide out of the way of the vulnerating body, while the other and deeper-seated structures, destitute of this property, are sometimes completely destroyed by its contact, the vessels and nerves being cut to pieces, the muscles torn into shreds, the bones crushed, and the largest joints laid open.   The scalp is sometimes extensively detached from the cranium by a fall upon the head, without any external wound, and a partially spent cannon ball, striking the belly obliquely, has been known to tear open the bowels, spleen, and liver, without leaving any mark or trace whatever upon the skin.   Such injuries, which are essentially subcutaneous wounds, are peculiarly severe, and are liable to be followed by the worst consequences ; often proving fatal on the instant, or, subsequently, from the effects of inflammation.

A contused wound occasionally exhibits the appearance of an incised wound.   Such an occurrence may readily arise when the soft parts are struck by a blow, kick, or fall, by which they are brought forcibly in contact with the osseous surface beneath, which thus acts as a resisting, vulnerating agent.   The effect will be more likely to arise if the tissues overlie a sharp ledge or bone.   The rent thus produced may be transverse, oblique, or longitudinal, and of variable width and depth.   The most common sites of such injuries are the face and head ; and an accident as simple as a blow with the fist has been known to occasion them in these regions.   A kick on the vulva, violently compressing this part against the pubic bone, may cause a similar lesion.   A rent, closely resembling an ordinary cut, is sometimes inflicted upon the lip by a front tooth in a blow, fall, or kick upon the mouth.

What is vulgarly called a *brush-burn* is a peculiar form of contused wound, the consideration of which properly falls under the present class of lesions.   It is most commonly met in manufacturing districts, and is generally caused by machinery in rapid motion, or revolving belts and similar contrivances.   It may also be produced by sliding rapidly down a hill or on rough ice.   The immediate effect of such contact is an abrasion of the cutaneous surface, in which the superficial structures of the skin are ground to pieces, at the same time that they are partially burned, while the underlying tissues are more or less bruised and disorganized.   The accident, unless very slight, is generally followed by severe pain and inflammation, occasionally terminating in gangrene.

In the *treatment* of contused wounds the leading indications are to arrest hemorrhage, to limit inflammation, and to promote the absorption of effused fluids.

Hemorrhage is controlled in the usual manner ; by compression, styptics, and hot water, if it be slight or venous ; by ligature, if it be copious and arterial.   When the bleeding vessel is concealed, as when the wound is subcutaneous, it may be extremely difficult to find it, owing to the bruised and infiltrated state of the parts, which often renders the search one of great labor and annoyance ; still, it is the only resource, and, therefore, the sooner the operation is performed the better, for it will certainly not at all

facilitate the undertaking if it be postponed until the supervention of inflammation. If the obstacles are unusually great, or if, in the attempt to tie the artery at the seat of injury, important structures are found to be in the way, it will be well to secure the vessel at some distance above the wound; trusting that any recurrent bleeding that may arise will either cease spontaneously, or yield to systematic and persistent compression.

Although we can hardly expect to obtain much, if any, union by the first intention in a contused wound, no harm can result from trying, as the effort cannot possibly make matters any worse. With this view, the edges of the wound should be as nicely approximated as possible, care being taken, of course, not to draw them together at all tightly; for due allowance must be made for swelling and drainage, which will always be more or less considerable in this class of lesions. No fear need be entertained respecting the use of sutures, provided they are introduced loosely, and not too numerously. I never hesitate to employ them in such cases, for I have never known them to be followed by any ill effects. It is only when they produce tension, or when they are made to embrace improper tissues, that they are likely to prove prejudicial. The same remarks are applicable to adhesive strips; they cannot be dispensed with, but they must be applied with great care, and in such a manner as to leave free room for the escape of fluids. Some authors advise that the edges of the wound should be neatly trimmed prior to their approximation, but such a procedure is never justifiable, unless it is perfectly clear that the tissues are dead, or so ragged and irregular as to render it impossible to effect accurate apposition. It will generally be well to intrust this matter, in great degree, if not entirely, to the operation of nature.

A few sutures and adhesive strips are usually the only dressings required. The parts, having been properly adjusted, are kept constantly wet with evaporating lotions, of which alcohol, largely diluted with water, is generally the best. Weak solutions of acetate of lead or Goulard's extract are also serviceable. Such cases are usually benefited by slightly stimulating applications, as they impart tone to the enfeebled vessels, and thus ward off erysipelas, so frequent in this class of lesions when treated in the ordinary manner. Leeches and iodine may become necessary when the inflammation is very active, and then a poultice will also generally be found to be more grateful than cold water or astringent lotions. The bowels and secretions must receive due attention, but severe purgation, and, in fact, all active depletion must be studiously guarded against. Proper allowance must be made, in every case, for the profuse discharges which are so liable to follow contused wounds. If mortification should occur, the treatment will not differ from that consequent upon ordinary inflammation. Pain and nervous symptoms are controlled by anodynes and antispasmodics. When granulations begin to spring up, the milder ointments will advantageously supersede the warm and cold applications; the former proving now too relaxing, and the latter too repressing.

The removal of extravasated blood is best effected by the tincture of arnica, in the proportion of three ounces to the pint of water, diligently applied with patent lint; and by cold, astringent lotions, such as acetate of lead, Goulard's extract, alum, and chloride of ammonium. After the lapse of a few days, the part may be frequently bathed with spirit of camphor, or soap liniment; painted with dilute tincture of iodine; or covered with a poultice made of crumbs of bread and common salt, or of the bruised roots of briony. Under this treatment an ordinary ecchymosis will often vanish in a few days; in the more severe cases a much longer time may be required.

When the extravasated blood appears as a distinct depot, or as a concentrated collection, attended with marked tension of the integument, the speediest way of getting rid of it is to make a small opening, barely sufficient to permit the blood to drain off, if it be fluid, or to be pressed out, if it be coagulated. The walls of the sac are then approximated by a compress and bandage, and irritation is kept down by the ordinary antiphlogistic means.

The treatment of brush burn is conducted upon general principles; the most soothing application, in the first instance, is a solution of acetate of lead in glycerine, and afterwards, especially if gangrene is threatened, weak lotions of nitric or carbolic acid and a yeast poultice.

SECT. VII.—PUNCTURED WOUNDS.

A punctured wound is a peculiar injury, deriving its name from the nature of the instrument with which it is inflicted, and the manner in which the tissues are divided. It comprehends all those lesions which are produced by nails, splinters of wood, thorns, pins,

needles, pieces of bone, or fragments of glass; or by the thrust of a dirk, bayonet, lance, sword, or any other sharp-pointed weapon. The operation of tapping affords a familiar instance of such a wound. The sting of the bee, wasp, and other insects, and the bite of the snake, dog, rat, and other animals, are all examples of this class of injuries, with this difference, however, that most of them are inoculated with the peculiar poison secreted by these creatures, and hence they naturally come to be considered separately. In common, every-day life, punctured wounds are most frequently met with in the hands and feet of the working classes. In dissecting and sewing up dead bodies the physician often punctures his fingers, and sometimes suffers severely in consequence, apparently, from the introduction of a peculiar septic virus, generated either during the act of dying or shortly after dissolution.

Punctured wounds vary much in extent, direction, and character; thus, they may be superficial or deep, narrow or wide, straight or crooked, simple or complicated: circumstances which must necessarily exert more or less influence upon their prognosis, treatment, and termination. Their depth is usually much greater than their width, and for this reason it is often extremely difficult to determine the amount of injury done to the parts in which they are situated.

A punctured wound is peculiar, not only as it respects the mode of its production, but also in regard to its effects. The tissues are forcibly pressed asunder, and, consequently, more or less contused, if not also a good deal lacerated. The wound made by the bite of a man and the inferior animals is usually both a punctured and a lacerated wound; so also when a splinter of wood, or a similar body, is violently driven into the flesh during an engagement on shipboard, or when a person is suspended by a hook or impaled upon a railing. A needle, nail, or a piece of bone, on the contrary, usually makes a purely punctured wound.

The pain attendant upon such a wound is frequently very excruciating, depending, evidently, not so much upon its extent as upon the injury sustained by the nerves of the part, and the bruised and condensed state of the tissues. Hence the suffering, which is often immediate, is sure to be immensely increased if the resulting inflammation is at all severe. It is always greatest, other things being equal, in persons of a nervous, irritable temperament. Much also will depend, in this respect, upon the nature of the vulnerating body. The puncture, for example, made in the operation of tapping the abdomen with a trocar generally causes very little uneasiness, while that of a nail, penetrating the sole of the foot, deep down among the muscles, usually produces the most intense agony. Violent nervous symptoms often supervene upon such accidents, and in hot climates, as well as in the hot seasons in the colder latitudes, they are liable to be followed by tetanus, especially among negroes and the more intemperate classes of whites. The disastrous effects which even the slightest puncture may occasionally produce, in a person of great susceptibility, is strikingly illustrated in the remarkable case, related by Sir Astley Cooper, of a young lady, who, on being pricked with a sewing needle, screamed, fainted, and died.

Punctured wounds are rarely attended with much hemorrhage, indeed frequently hardly any at all; if a large artery, however, has been penetrated, then the bleeding may not only be copious, but, perhaps, almost instantaneously fatal. The thrust of a sword, lance, dirk, or bayonet into the chest, abdomen, neck, or thigh, often literally taps the vessels, destroying the patient in a few minutes. The shock of such a lesion, too, may prove to be of consequence; even a slight puncture is sometimes followed by excessive prostration, and it has been found that soldiers, during engagements, are seldom able to continue the fight beyond a few minutes after they have been deeply pricked by the point of any of these weapons. The shock is excessive, and the patient soon falls into a fatal syncope.

Another peculiarity of punctured wounds is their liability to be followed by erysipelas, angeioleucitis, abscess, contraction of the limbs, and wasting of the muscles. Mortification will not be likely to ensue unless the main artery or nerve of an extremity has been severed, or the system at the time of the injury is in a bad condition. Punctured wounds of the scalp, hands, feet, and joints, especially the larger, as the knee, ankle, elbow, and wrist, are particularly prone to be followed by severe nervous and inflammatory symptoms, and also by erysipelas, the latter generally coming on within less than thirty hours after the infliction of the injury. When the lymphatic vessels become involved, as they often do, the disease is indicated by red lines, extending from the seat of the injury towards the nearest lymphatic glands. A similar phenomenon, along with more or less induration, is witnessed when the veins participate in the mischief; an occurrence by no means uncommon.

The secondary effects of punctured wounds are often very serious, entailing much suffering, with occasional deformity and loss of limb, and demanding much care on the part of the practitioner. Needles, pins, fragments of glass, and pieces of bone sometimes enter the tendons, ligaments, and aponeuroses, and, causing severe and protracted irritation, ultimately lead to irremediable contraction.

Much of the local distress in punctured wounds arises from the injury done to the nerves, by the partial division of their filaments. The gap thus left is nearly always filled up with hard, callous matter, of a fibrous, or fibroplastic structure, ill adapted for the transmission of nerve fluid, and almost invariably the seat for a long time afterwards of more or less pain and tenderness. Neuralgia is also a common occurrence; and not unfrequently all the muscles in the neighborhood of the affected part are eventually completely atrophied and rendered useless.

The *treatment* of punctured wounds consists, first, in the extraction of the foreign substance, in case it has not been already dislodged; secondly, in checking hemorrhage; and, thirdly, in moderating inflammation and preventing the development of nervous symptoms.

To determine whether any extraneous matter remains in the wound, all that is necessary, in most cases, is simply to inspect the vulnerating body. If this exhibit marks of fracture, the probability is that a part of it has been left behind; if so, the probe and finger will assist in detecting it. Should the wound, however, be very deep and narrow, it may be necessary, before this can be done, to make an incision, the extent of which must depend upon the circumstances of each particular case, the only care to be observed being the avoidance of important structures, especially vessels, nerves, and tendons.

When a needle or other slender substance is imbedded in the flesh, or buried in the connective tissue, its presence may often be detected by folding up the skin over it, or making gentle and systematic pressure with the ends of the forefingers at its supposed site, which is generally indicated, at least in recent cases, by a little puncture, perhaps not as large as a flea-bite, upon the surface. Sometimes the local pain or tenderness affords valuable information as to the precise spot where the needle is lodged. The surgeon should not hesitate, when there is reason to believe that the foreign body is retained, to make a free incision for the purpose of extracting it; it is much better to do this at once than to temporize with the case, or to wait until serious symptoms arise, when such a procedure becomes inevitable, although it may now be too late to prevent altogether its bad effects. I have found after long experience that the best forceps for extracting needles and other sharp-pointed bodies are such as are rather long and slender in the blades, with deeply serrated surfaces. The ordinary dissecting forceps are generally worse than useless, especially when, as often happens, the substance is firmly imbedded. Mr. Marshall, of London, has suggested a very ingenious mode of detecting the fragment of a needle imbedded at some depth. It consists in holding a powerful magnet upon the suspected spot for a quarter of an hour, in order to influence the fragment, when, a finely hung polarized needle being suspended over it, deflection will ensue if iron be present.

In the sole of the foot, pieces of bone, glass, and other small bodies are sometimes buried deeply beneath the plantar aponeurosis, where it is often impossible to determine their presence, however carefully searched for. A case which forcibly illustrates this fact fell under my observation, many years ago, in a boy, nine years old, who was wounded by a piece of chicken bone, nearly an inch long, which entered the sole of the foot, and lodged deeply in the substance of the flexor muscles, in contact with the metatarsal bones. Pain and swelling soon followed, but the boy, despite his suffering, continued to walk about, limping, of course, for upwards of a fortnight; the weather, in the mean time, being excessively hot. Suddenly symptoms of tetanus came on; Professor Willard Parker, then my colleague, and I now saw the case, and, although every effort was made to discover the foreign body, it could not be detected, such was the depth at which it was situated. Death followed in a few days, when the bone was found to be so completely buried as to require a very elaborate dissection to remove it.

Removal of foreign bodies, deeply imbedded in the flesh, will be greatly facilitated if the limb be previously constricted with the elastic roller. All barbed instruments, hooks, and similar substances, should be extracted either by counteropenings, or by pushing them across the part in which they are imbedded. Any attempt to extricate them by pulling at them in the direction in which they entered would only increase the difficulty, unless a very free incision be made over them.

The bleeding in punctured wounds generally ceases spontaneously. If a large artery has been laid open, or divided, it must be exposed, and tied at each extremity, in the usual manner. If this cannot be done, compression may be tried, as in the treatment of aneu-

rism ; or, this failing, or not being deemed admissible, the main trunk of the vessel is tied at some distance from the injury.

To prevent the occurrence of severe pain and nervous distress, a full anodyne should always be given, if the case is at all severe, immediately after the accident, and the part wrapped up in flannel, wrung out of warm water and laudanum and frequently renewed.

If the general health suffer, a dose of calomel should be administered, followed by oil or senna. If fever arise, antimonial and saline preparations with morphia may be required, to act on the skin and bowels, to allay pain, and to induce sleep. If matter form, as indicated by the tension and throbbing of the part, free incisions must be made ; erysipelas, angeioleucitis, and phlebitis being treated in the usual manner. Nervous symptoms are combated with the liberal use of anodynes, bromide of potassium, chloral, and other means.

Along our Indian borders very severe wounds, of a punctured character, or partly punctured and partly incised, are often inflicted with the *arrow*, which, as is well known, is capable of being projected, with extraordinary precision, to a great distance. Being usually made of the young willow, or other suitable wood, it varies in length from two feet to two feet and a half, and is feathered in the greater part of its extent, in order to facilitate its movements and increase its speed through the air. The head is generally furnished with a spear-shaped piece of flint, obsidian, or iron. This, which is technically termed the point of the weapon, is of a flattened conical figure, its length from base to apex ranging from three-quarters of an inch to an inch and a half; the corners, or angles, project in a line with the side of the free extremity, and are usually upwards of an inch in width, the whole arrangement being such as to enable the instrument to operate on the principle of the barb of a fish-hook. Thus constructed, the point is securely fixed in a notch on the head of the arrow by means of the tendinous shreds of the deer, coated with the resin of the fir-tree.

It is supposed that many of our Indian tribes poison their arrows, so as to inflict a more deadly wound; but I am told by a former pupil, Dr. William F. Edgar, that this practice is peculiar to the savages inhabiting the mountainous regions watered by Pitt River, one of the northern branches of the Sacramento. These people, it is said, use the poison of the rattlesnake, by grinding the dried head of that reptile into an impalpable powder, which is then applied by means of the putrid blood and flesh of the dog to the point of the weapon, the wound made by it proving speedily mortal.

Wounds made by arrows often, Dr. T. C. Henry, U. S. A., informs me, partake of the nature of incised wounds, or those inflicted by the thrust of the small sword ; and a similar remark has been made by Dr, J. H. Bill, in an elaborate paper on this class of injuries in the American Journal of the Medical Sciences for October, 1862. The iron heads of these weapons are exceedingly thin, and, when propelled with great force, make a clean cut, a portion of which not unfrequently unites by the first intention. Arrow wounds are often attended with great shock, especially when inflicted upon internal organs, resembling, in this respect, gunshot and similar lesions.

Arrow wounds are frequently complicated with copious hemorrhage, and they are also extremely liable to be followed by profuse suppuration, the matter often burrowing extensively among the muscles and other structures. Erysipelas and pyemia are not uncommon. Arrow wounds of the internal organs, as the lungs, liver, spleen, and intestines, almost invariably prove fatal, especially if the point of the missile, detached from its shaft, is retained among the tissues or lodged in a splanchnic cavity.
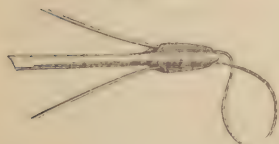
Fig. 106.   Fig. 107.

Contrivances for the Extraction of the Point of the Arrow.

In the treatment of arrow wounds, the first indication is to extract the extraneous substance, and then, bleeding having been arrested, to limit the resulting inflammation by appropriate antiphlogistic measures. Long and deep incisions will often be required to effect dislodgment, especially if the arrow is impacted in the head of a bone, or buried at a considerable depth among the muscles and aponeuroses. The best probe for determining

its situation is the finger. Rotating the shaft of the arrow upon its axis, or twisting it between the thumb and forefinger, is a good method for ascertaining whether the point of the weapon lies loosely among the soft structures, or is imbedded more or less firmly in bone. Stout forceps, with long and well-serrated blades, should be employed, and the success of the operation will be greatly increased if care be taken during the manipulation not to detach the shaft from the point of the arrow. The extraction, as stated by Dr. Bill, is sometimes greatly facilitated by means of a noose made of stout annealed wire, passed through a double canula, a Coghill's suture twister, fig. 106, or the contrivance represented in fig. 107, carried around the point of the weapon. If abscesses form, they should be promptly opened, to prevent infiltration and destruction of tissue.

SECT. VIII.—TOOTH WOUNDS.

Wounds inflicted by the bite of the human subject and of the inferior animals, as the dog, cat, or rat, partake of the nature of contused, lacerated, and punctured wounds. Such lesions are by no means uncommon, and, from the danger which so often attends them, are worthy of special consideration. I have met with a number of cases of severe suffering from wounds of the fingers received in the act of striking persons upon the mouth. The inflammation consequent upon such injuries is prone to run into erysipelas, especially if, at the time of the accident, the constitution is in a deranged state, and it is sometimes so violent as to be followed by mortification. In 1851, a distinguished jurist struck a man upon the mouth, wounding his finger slightly against his teeth. Erysipelas speedily supervened, and the hand was obliged to be amputated; subsequently the disease reappeared in the stump, and necessitated the removal of the arm.

A woman, forty-seven years of age, always in good health, scratched the skin slightly over the knuckle of the right index-finger in a blow in which she struck the front tooth of a servant girl; only a few drops of blood were lost, and there was hardly any pain. Within two hours afterwards, however, the part began to ache and throb; the finger swelled rapidly to an enormous degree; the whole limb became enlarged and exquisitely sensitive; and a deep red line extended as high up as the axilla, the lymphatic glands of which were very tumid and tender to the touch. Great constitutional disturbance, attended with loss of sleep and appetite, supervened; and a large abscess formed in the theca of the finger, followed by necrosis of the last phalanx and ankylosis of the other joints. The whole limb remained for a long time sore, tender, and swollen, and upwards of a year elapsed before the reëstablishment of the general health.

A farmer, thirty-six years of age, struck a man upon the mouth, receiving a superficial abrasion over the knuckle of the little finger of the right hand. Violent erysipelas of the whole limb followed; the finger became enormously swollen, and a large abscess formed in it, eventuating in necrosis of the phalanges. The general health suffered greatly, and a fresh attack of erysipelas broke out after the amputation of the finger. Many months elapsed before final recovery occurred.

A physician, upwards of seventy-two years of age, received a small wound upon the left index-finger, in striking a lad upon the front teeth. Erysipelas soon showed itself, attended with exquisite pain, and extending up the limb beyond the elbow. After much suffering, in which the constitution seriously participated, the inflammation, at length, disappeared, leaving the finger stiff, crooked, withered, cold, and benumbed.

A farmer, forty-seven years of age, in good health, in December, 1851, struck a man on his mouth in such a manner as to bring the knuckle of the metacarpal bone of the right ring-finger forcibly in contact with the incisor teeth; the skin was slightly broken, but he experienced no particular inconvenience at the time. The same evening, however, the hand and finger became painful and stiff, and the next day they began to swell and to present an erysipelatous appearance. Excessive suffering ensued, producing profound constitutional disturbance; and finally, in about three weeks, a large abscess formed in the hand, requiring the lancet. When I first saw the case, at the end of this time, the thumb and all the fingers were stiff and immovable; the wrist-joint was also much affected, and, in fact, the whole limb was sore and painful. In August, 1852, the thumb and fingers were still rigid and useless, much colder than natural, numb, and considerably attenuated. Every attempt to bend the fingers was attended with severe suffering. The right ring-finger was ankylosed at the metacarpo-phalangeal joint. There was still much uneasiness in the palm of the hand, and the whole limb was atrophied.

The bite of the human subject is often followed by violent symptoms, coming on soon after the infliction of the injury. A considerable number of such cases have fallen under

my observation, and in several I have experienced much difficulty in saving limb and life. I do not presume that the saliva in this class of wounds has anything to do with the production of the bad effects by which they are so liable to be succeeded; the parts are badly bruised, or bruised, lacerated, and punctured, and it is well known how prone such injuries, however induced, always are to be followed by erysipelas and other serious consequences, especially in persons of intemperate habits or disordered health.

The bite of the inferior animals, particularly if they are much enraged at the time, is often succeeded by a very bad form of erysipelas. Many years ago I attended, along with Dr. Trimble, a child, three years of age, who, a few days previously, had been bitten by a rat in one of his fingers. A severe attack of erysipelas soon came on, involving the whole hand and forearm, and causing most violent local and constitutional suffering. The injured part was converted into a large unhealthy ulcer, discharging a thin, sanious fluid, and was a long time in healing. Recovery finally took place, but not without permanent ankylosis of the finger, and partial atrophy of the hand and forearm. The bite of the dog, cat, horse, mule, ass, and camel frequently occasions violent inflammation and great general disturbance. Prescott Hewett has reported a case in which the bite of a ferret caused pyemia and death. Severe wounds, combining all the unfavorable conditions of punctured, lacerated, and contused wounds, may be inflicted by the claws of the feline races of animals, as the cat, lion, and tiger. The inflammation that follows upon the injury inflicted by the bill of certain birds, as the turkey and duck, is often extremely severe, and even dangerous, cases of gangrene and death having been witnessed from its effects. A fatal wound has sometimes been inflicted by the spur of a cock, and the peck of a hen.

The treatment of tooth wounds and abrasions must be conducted upon the same general principles as that of ordinary contused and punctured wounds. The part, however, should always, as a preliminary measure, be well cleansed and bathed with warm salt water, to rid it of any saliva and any other matter that may have been deposited by the teeth; after this, the best application will be an emollient poultice wet with a solution of acetate of lead and laudanum, followed, if necessary, by leeches, and, if matter form, by early and free incisions. Dilute tincture of iodine, pencilled over the inflamed surface around the wound, will also be useful. The best internal remedies are calomel and opium, with an active purge at the commencement of the treatment. When the case is obstinate, alteratives and tonics with change of air may be required.

SECT. IX.—GUNSHOT WOUNDS.

Gunshot wounds are injuries inflicted by fire-arms, as pistols, muskets, rifles, carbines, cannon, shells, and rockets; and are dangerous or otherwise according to their extent, the nature of the affected structures, and the state of the system at the time of their receipt. Occurring in all parts of the body, they may, in one case, be so slight as hardly to attract serious attention, while in another they may be so severe as to cause death upon the spot, either from shock or loss of blood, or, secondarily, from the violence of the resulting inflammation. Even when the person is so fortunate as to escape with his life, he often remains miserable ever afterwards on account of his mutilated condition, the repeated formation of abscesses, or the occurrence of neuralgic pains, which, hardly leaving him any respite from suffering, keep his mind and body in a state of constant irritation, and thus utterly incapacitate him for enjoyment and usefulness.

The missiles generally employed in civil life, in this country, are pistol, rifle, and musket balls, varying in volume from that of swanshot to that of a small marble. The round bullet, formerly used in our army, has been entirely superseded by what is called the new rifle-musket bullet, on account of its greater efficiency. It is of a cylindro-conoidal shape, with a hollow base and three circular grooves, weighs 500 grains, and penetrates, when impelled by a charge of sixty grains of powder, at a distance of 200 yards, eleven one inch pine planks, placed one inch and a half a part. At the distance of 1000 yards it penetrates three and one-fourth of such planks.

The British, French, and Russians employ a considerable variety of bullets adapted to the peculiarities of their respective services. The Enfield ball, used by the English since 1853, has superseded nearly all other missiles of that description. It is a long conical ball, hollow in the base, and weighs $\mathrecal{3}$j and $\ominus$ij. The Martini-Henry ball weighs about 428 grains. The French Minié ball weighs $\mathrecal{3}$j, $\mathfrak{Z}$ij and $\ominus$ij, and the Russian ball, also conical, weighs $\mathrecal{3}$j and $\mathfrak{Z}$vj. The Chassepot ball is nearly cylindrical, and weighs 380

grains. The Prussian ball is somewhat egg-shaped, weighs 530 grains, inflicts an ugly wound, and frightfully shivers the bones. The ball of the mitrailleuse weighs one ounce and three-quarters; the Austrian ball 400 grains.

It has been found in military operations that the cylindro-conoidal ball, meeting with less resistance from the atmosphere than the round, passes, consequently, to a much greater distance, and does more terrific execution upon entering the body, generally proceeding in a straight line, and fracturing and comminuting the bones in a most frightful manner; thus causing a much greater mortality, as well as a more frequent necessity for amputation. The conical ball, moreover, is less liable to be flattened and divided than the round ball, and the aperture of exit is nearly always opposite to that of entrance, which was not so often the case formerly. Much of the gravity of gunshot wounds of late years has arisen from the substitution of the conical bullet. To show with what force a Minié ball occasionally acts, it may be stated that it has been known to pass through the bodies of two men and to lodge in that of a third standing some distance behind.

Sometimes two balls are united by a bar or chain of iron, and put in a cartridge, thus producing, when fired, a terrible wound, as often happened in the Schleswig-Holstein war. In the naval action off Camperdown, in 1797, great destruction was wrought by the Dutch, by the discharge of bags of nails and pieces of old iron. During the war in the Crimea, the Russians occasionally employed an incendiary ball, consisting of a small cylinder of copper filled with a detonating substance, made up in the form of an ordinary cartridge, and discharged from a musket, the projectile, on striking an object, exploding with violence.

Cannon balls are solid bodies, made of cast-iron, and ranging in caliber from one to many pounds, according to the object which they are designed to accomplish. They are either round, or of a cylindro-conoidal shape, the latter of which possesses the same advantage over the former as the cylindro-conoidal bullet over the spherical. A grape-shot is composed of nine cast-iron balls, disposed in three layers of three balls each. Formerly the shot were confined in a canvas bag, fastened to a wooden spindel with a strong cord, the whole bearing a faint resemblance to a bunch of grapes, whence the name. From this the canister shot differs principally in being contained in a tin cylinder closed at the top and bottom. The balls, arranged in four layers, are packed in sawdust. "Shells are large hollow spheres of iron loaded with gunpowder, which may act either in their entire form as solid balls, or subsequently by the explosion of their contents, and their subdivision into numerous splinters, by which their ravages are greatly extended. Shrapnell shells, so named from their inventor, are hollow spheres, loaded partly with gunpowder, partly with balls."

Slugs and fragments of cannon balls often occasion frightful wounds, lacerating the soft parts, crushing bones, laying open joints, penetrating splanchnic cavities and committing other ravages, either fatal at the moment or proving so by secondary involvement.

A pistol ball. if fired near, inflicts quite as deadly a wound as a musket, carbine, or rifle ball. This missile is now generally of a conical shape, and operates with great effect, both upon the soft and hard structures.

Serious injury, extremely liable to be followed by tetanus, is often inflicted with the toy pistol, as it is termed, in such common use in this country on the fourth of July and during our Christmas holidays. The hands and fingers are the parts usually wounded, and the lesions, even when superficial, are very liable to cause severe nervous symptoms, especially during our hot summer months.

A buck-shot wound is at present of rare occurrence. During our last war with Great Britain it was sufficiently common. Buck-shot are sometimes inclosed in wire cartridges, and are then very effective, carrying close for twenty yards, diverging somewhat at fifty, and entering separately at one hundred and fifty, readily penetrating a yellow pine board an inch thick.

Small *shot*, striking the body in a concentrated form, produce effects similar to those of a large bullet; if they are scattered, the injury will be less grave, unless they happen to hit an important organ, as the heart, brain, or spinal cord, when death may ensue in a few minutes, or, more remotely, from the resulting inflammation, as in several instances that have fallen under my own observation. Lachése ascertained by numerous experiments that a load of small shot discharged at a dead body, at a distance of ten inches, will make a clean, round opening; at from twelve to eighteen inches the opening will be very ragged and irregular; while at thirty-six inches each shot will enter separately.

Grave injury sometimes follows the explosion of a *percussion-cap*. Such accidents are sufficiently common among sportsmen, whose pleasures of the chase are often requited by

the loss of an eye, and by the most excruciating suffering, from the lodgment of a piece of the foreign body in one of the chambers of that organ, or in the substance of the iris, lens, or vitreous humor.

Wadding discharged from an ordinary fowling-piece may occasion a fatal wound, as in an instance which occurred, many years ago, at a Philadelphia theatre where, from this cause, a man lost his life in a sham-fight upon the stage. The wadding—a common cartridge—struck the side of the head, fracturing the temporal bone, and, passing across the brain, lodged against the falx of the dura mater, from which it was extracted after death by Dr. John Rhea Barton. In 1838, a girl was killed in England by the discharge of a gun loaded with paper pellets, some of which penetrated the body and lodged in the lungs and liver. In two other instances life was destroyed by a single pellet; in one, by laying open the fifth intercostal artery, and in the other by breaking the orbital plate of the frontal bone, and injuring the brain. A case is recorded of a man being fatally wounded by a kid-glove with a button attached to it; it was discharged from a blunderbuss loaded with powder, and struck the person, who was standing ten feet off, upon his abdomen, in the cavity of which it was found on dissection.

Powder alone, without any wadding, may, when discharged near the body from a gun, pistol, or fowling-piece, occasion fatal injury. From the experiments of Lachèse it appears that, when the distance does not exceed six inches, and the weapon is large and strongly charged, the wound thus made will bear some resemblance to that produced by a small shot, each particle that escapes combustion acting like a pellet. The fact that the mere explosion of powder near the body is capable of causing severe bruises, contusions, lacerations, and even death, has long been familiar to observers. A remarkable case of the latter occurred in this city in 1847, in a lad, a patient of Dr. Paul Swift. The charge, fired from a pistol, entered the left hip, inflicting a wound four inches in depth by one inch in diameter, blackened throughout by the powder, grains of which adhered to its surface. The integument and muscles were severely torn and discolored. Death occurred on the seventh day from tetanus. The instances are quite numerous of great suffering, mutilation, and disfigurement from the lodgment of grains of powder in the eyes, face, neck, and other parts of the body. Stone-quarriers are particularly liable to such accidents.

In its character, a gunshot wound is a punctured wound, with more or less of the nature of a contused and lacerated wound; at the opening of entrance, and for some distance around, the tissues are bruised, but as the ball passes onward it tears the parts, and at the opening of exit they often look as if they had been cut with a sharp knife. The effects of the transit of the missile upon the soft textures may be explained, as was first suggested by Sir Charles Bell, by a reference to a diagram consisting of three concentric rings, as in fig. 108. The first, including the tubular wound, is bounded by tissues which are so compacted, condensed, or contused as to deprive them partially of their vitality, or, at any rate, to place them in such a condition as inevitably to lead to suppuration; consequently this por-

Fig. 108.

tion of the wound seldom unites by the first intention. The structures between the first and the second rings, having sustained less injury, will also inflame, but only, as a rule, in such a manner as to give rise to a deposit of lymph and pus; while those between the second and third circles will either retain their natural properties, or, becoming excited, will merely experience some slight serous infiltration.

The above phenomena may generally be studied to the greatest advantage in deep flesh wounds, as those of the thigh. In such cases there is often a considerable slough of the bruised tissues, upon the separation of which the parts are seen to suppurate and to form granulations, while farther on they are hard, next œdematous, and beyond this natural. These phenomena, however, do not generally pervade the entire length of the wound; for frequently a considerable portion of the track unites by adhesive action, the tissues being lacerated instead of contused, as they are in the early stage of the passage, and, consequently, favorable to restoration. The precise point where the tubular wound loses the character of a contusion and assumes that of a laceration cannot usually be ascertained, as it must necessarily vary very much in different cases, and under different circumstances.

The preceding remarks in regard to the injury inflicted by the projectile are chiefly applicable to the smaller kinds of balls, such as the pistol and rifle; the larger ones are generally productive of more serious mischief, and hence it often happens that the wound sloughs in its entire length, from the opening of entrance to that of exit; there being afterwards, when the dead parts have separated, extensive and tedious suppuration, the

matter, perhaps, burrowing deeply among the soft structures, and thus greatly retarding the process of repair.

Disposition of the Projectile.—The manner in which the projectile is disposed of varies; sometimes it lodges, and then, of course, it makes but one opening; at other times it passes completely through the part, and so leaves two apertures, one of entrance, the other of exit. Cases occur where one ball may make three, four, or even more holes. Thus, if it encounter a sharp edge of bone, as the crest of the tibia, it may be cut into two or more pieces, each of which may afterwards issue at a separate point. Dupuytren met with an instance in which a ball of this kind made five orifices; and at Antwerp the younger Larrey saw six holes made in a similar manner. Again, a ball piercing the surface, just above the wrist, may be unable to penetrate the aponeurosis of the forearm, but, travelling along for some distance under the integument, may emerge below the elbow; then, the limb being considerably flexed at the moment, it may reënter the skin a second time at the inferior part of the arm, and finally escape near the shoulder-joint; thus leaving four apertures, two of entrance, and two of exit. Such an occurrence is, of course, very rare; but its possibility is worthy of remembrance, as it is of great interest in a medico-legal point of view. A man, for example, might be shot in a duel, and his friends seeing the number of openings in the limb, might accuse his adversary of foul play, on the ground that he had used more than one ball.

A curious case has been related, by Hunter, of a young man who was shot in the abdomen by three bullets discharged simultaneously from the same weapon, with the effect of making only two openings of entrance and two of exit, one of the missiles following closely in the track of one of the others, as was proved by the fact that they all lodged by separate orifices in the wainscot of the apartment where the accident occurred. During the French war in Algeria, a grenadier was pierced in five places, all wounds of entrance, by a single ball, divided into five pieces by first striking a rock, the fragments rebounding at various angles.

A ball striking an extremity may pass not only completely through it, but also through its fellow, thus making four openings; or it may perforate the upper part of the thigh and then pass through the head of the penis, leaving two orifices in the former and two in the latter, as in a case which I saw in the Hospital at Alexandria, under the care of Dr. Sheldon, after the engagement near Centerville, Virginia, in July, 1861; or, finally, it may traverse both buttocks, or it may perforate one and lodge under the integument on the outer side of the other, as in a man who was wounded in the battle of Bull Run.

When there is only one opening, it is natural to conclude that the ball has lodged, and this, as already stated, is usually the fact. Instances, however, occur, although rarely, where the reverse is the case. Thus, a ball has been known to pass some distance into the pectoral muscle, and to be immediately ejected by the recoil of a rib. The knee-joint has occasionally been opened, the ball being supposed to have lodged in the head of the tibia, but upon amputating the limb none was found, although there was but one opening. Lastly, a ball may enter the body, perhaps rather deeply, along with a piece of cloth, upon extracting which the missile may drop out.

Large balls, fragments of shell, pieces of iron, and other substances, occasionally bury themselves deeply among the muscles, where, from the small size of the opening of entrance, they may long remain undiscovered. Larrey extracted a ball, weighing five pounds, from the thigh of a soldier, who had suffered so little inconvenience from it that it had been entirely overlooked by the surgical attendant; and Hennen refers to a still more remarkable instance as having occurred at Seringapatam. At the battle of Fort Donelson, Dr. Henry W. Davis, of Chicago, amputated a thigh, in the muscles of which a shell, weighing twelve pounds, and measuring four inches and a half in diameter, was buried. In a case referred to by Longmore, a grape-shot, weighing one pound and two ounces, remained in the back of the pharynx for three weeks without exciting any suspicion of its presence.

Considerable difference generally exists between the openings of entrance and exit. The former is usually rounded with even or slightly inverted edges, as if the skin had been tucked in a little, and there is frequently more or less of a bluish or blackish discoloration of the adjacent surface, from the contact of burnt powder, deposited upon the ball at the moment of the explosion, and rubbed off as the ball strikes the body. When the discharge takes place within a few feet of the surface, scorched grains of powder often adhere to the skin, or may even be imbedded in its substance. Occasionally the margins of the orifice have a pale, dead-like aspect, or they may be simply of a livid hue, from the effects of contusion. The opening of exit, on the contrary, has generally a slit-like appearance, looking as if it had been made with a sharp knife rather than an obtuse

body; it is free from discoloration, and its edges, instead of being inverted, are turned out. I have met with cases where both openings had an incised appearance, but such a condition is uncommon.

The size of the two openings is variable. The round ball generally makes a larger orifice of entrance than of exit, the reverse being the case with the conical ball. These peculiarities were remarkably apparent in the wounds of the troops after the battle of Bull Run, in July, 1861. I had occasion also to notice the immense size of the openings in gunshot wounds of the integuments, made by the conical ball, especially when the two apertures were close together. In nearly all the cases of this class of lesions that I observed during the war, the holes, particularly that of exit, were disproportionately large, as well as remarkably irregular and ragged.

Experiments performed by Dr. Sarazin, of Strasbourg, upon the dead subject, with the Chassepot rifle, show that the size of the orifice of entrance is essentially the same as that of the projectile itself, whereas the diameter of the orifice of exit is enormous, being from seven to thirteen times larger than that of the ball.

Shell wounds, and wounds inflicted with stones, nails, splinters, and similar missiles, always exhibit a lacerated appearance, owing to the irregular shape of the vulnerating body. A similar character is often imparted by flattened bullets, and by bullets entering the surface flatwise, as occasionally happens when their course is changed by some intervening object.

When any doubt exists in regard to the nature of the two holes, it may often be promptly dispelled by a careful examination of the openings in the patient's clothing, as here the aperture of exit is invariably the larger and more ragged of the two.

Wounds inflicted by the explosion of torpedoes are usually attended with excessive laceration and contusion of the soft parts. Dr. S. W. Gross, who saw a number of wounds of this kind during our late war, found that grave and deep-seated injuries occasionally occurred without any apparent lesion of the skin, and that very generally they caused complicated fractures, or even carried away portions of a limb; in either event demanding amputation.

A ball in rapid motion, under the impulse of a strong charge of powder, flies like an arrow; it does not revolve on its axis, and, consequently, on reaching the body, it passes through in a straight line, dividing everything before it, and perhaps issuing at a point directly opposite to that of its entrance. If, on the other hand, its force is partially spent, it will either not enter at all, or, if it enter, it will be turned out of its course, the slightest resistance, as that offered by a tendon, ligament, or aponeurosis, serving to change its direction. The circumstances which tend to weaken the force of a ball are two, the attraction of the earth and the resistance of the atmosphere. A strong wind blowing perpendicularly to the direction of the American rifle-musket ball, will deflect it from its course twelve feet in 1000 yards, about one-fourth that distance in 500 yards, and about six inches in 200 yards. Besides, its impulse may receive a serious check by coming in contact with the person's accoutrements or some article of dress, as a button, buckle, or breast-plate, or any substance that may, at the moment, happen to be in his pocket, as a key, pencil, knife, watch, or coin. If, from these, or any other causes, the force of the projectile is partially spent, it may, on reaching the surface, either glance off, or, if it enter, it will be likely to be deflected, the course which it then sometimes pursues being very remarkable. Thus, a ball has been known to pierce the forehead, but instead of penetrating the frontal bone, it passed round the skull, underneath the scalp, and lodged upon the occiput, at a point nearly opposite to that of entrance; or, what is still more extraordinary, it travelled nearly completely round the head, issuing only a short distance from the place where it struck. In the same manner a ball has been found to describe the circumference of the chest, its course being marked by a reddish weal or zone. Cases are mentioned by military surgeons in which the missile, piercing the wall of the chest by the side of the sternum, made the circuit of the thoracic cavity by passing between the costal and pulmonary pleuræ, and either falling down upon the diaphragm, or lodging in the wall of the chest behind, without inflicting the slightest injury upon the lung. Examples of a similar kind occasionally occur in the abdomen, the ball, after piercing the skin, being deflected by the tendon of the external oblique muscle, so as to cause it to course round the belly beneath the integument, and effect a lodgment near the spine, or, perhaps, emerge somewhere upon the back. Finally, cases are not wanting, although they are rare, where the missile entered the abdomen in front, and issued behind, in a straight line, without wounding any of the viscera. Such occurrences find their counter-

part in sword, bayonet, and dagger wounds of the abdomen, in which the walls of that cavity are sometimes completely transfixed, and yet its contents escape unharmed.

A case has been related by Dr. William H. Herring, in which a musket ball, entering the upper and back part of the neck, was discharged at the end of five months by the anus, having, as was supposed, passed by ulceration into the pharynx and thence into the stomach.

When soldiers lie on the abdomen with the head towards the enemy, the ball may pass vertically through the skull, and either lodge or emerge at a distant part of the body. An instance occurred during the war in the Crimea, in which a ball, entering the top of the cranium, traversed the neck, back, buttock, and thigh, and escaped near the knee.

A long bone is occasionally terribly shattered and comminuted by a bullet without the destruction of its continuity, some of the splinters being forcibly driven into the medullary canal, where they are retained, and act as foreign bodies, keeping up inflammation and discharge for an indefinite period. Hennen long ago called attention to this lesion, of which numerous cases occurred during our late war.

Different tissues possess the faculty of deflecting balls in different degrees. Thus bone offers a greater amount of resistance than cartilage, cartilage than tendon, tendon than aponeurosis, and aponeurosis than muscle. Arteries often escape in a remarkable manner, their astonishing elasticity enabling them to glide away from the flying projectile. Common integument, too, readily throws a partially spent ball out of the straight line. Deflection of every description, however, is much less frequent now than formerly, owing to the substitution of the conical for the round ball, the former readily penetrating everything, even when fired at a great distance, whereas the latter is easily spent, and arrested on coming in contact with the more resisting tissues.

A ball, upon meeting a sharp bone, as the crest of the tibia, is sometimes cut in two as smoothly and evenly as if it had been divided with a knife. A gentleman was shot in a street rencontre, the ball striking the clavicle, which split it into two nearly equal portions, one bounding off and escaping, the other lodging in the lower part of the neck, from which I removed it several months afterwards. Cases have occurred in which, as before stated, bullets have been cut into a number of pieces, each perhaps making a separate orifice in the skin. The conical ball suffers much less frequently in this manner than the round.

When a ball strikes a bone, it may be arrested in its substance, or it may perforate it, lodge in the soft parts, or make its escape. In the latter event, the opening of entrance in the bone will generally be somewhat round, and comparatively small, whereas that of egress will be large, ragged, and irregular, with everted edges. The old round ball, in its transit through a bone, often made a hole much bigger than itself, especially if its force was partially spent. Indeed, cases were occasionally observed in which the opening was so capacious as to admit not only the ball, but also the barrel of the weapon from which it was discharged. The conical ball, although it makes a comparatively small aperture of entrance, commits much greater havoc than the round, owing to the manner in which it breaks and comminutes the osseous tissue, the loose splinters themselves thus often becoming a source of severe injury to the soft structures, contusing and lacerating them in every direction.

Grave injury is sometimes inflicted upon a bone, even without the occurrence of fracture, simply from the violence of the shock which it experiences. The bullet strikes its surface with great force, bruising the periosteum, and causing dreadful concussion of the osseous tissue, but the force with which it is impelled is not sufficient to enable it to effect penetration. In such a case erysipelatous inflammation is very liable to be followed by exhausting suppuration, and, perhaps, sloughing and death.

Immense damage is sometimes sustained by the soft parts, by fragments of bone being forcibly driven into their substance, sometimes at a great distance from the site of the original injury. A case occurred in the Crimea, in which a piece of the lower jaw was detected behind the right clavicle; and Professor Hamilton mentions an instance in which, during the late war, a ball and four incisor teeth were removed from beneath the skin at the top of the sternum. In gunshot wounds of the extremities, splinters of bone often do more mischief than the missile by which they are inflicted.

The older writers on military surgery speculated a great deal respecting what used to be called the windage of a ball. It is well known that the most horrible injuries may be inflicted upon the body by shell and round shot, completely pulpifying the muscles, lacerating the vessels and nerves, laying open large joints, and literally crushing the bones, and yet, perhaps, hardly bruise the skin, much less produce any serious wound. The

true cause of these injuries is the manner in which the projectile strikes the surface.   As before stated, a ball in rapid motion will, on reaching the body, pass through it in a straight line ; or, instead of this, it will, if large, as in the case of a cannon ball, carry away the part completely.   But it is very different when the missile is projected lazily, or when, from the great distance over which it has travelled, its force is measurably exhausted. Then the slightest resistance will tend to deflect it, or change its course ; it no longer passes in a straight line, but rolls or turns upon its axis after the manner of a billiard ball ; and hence if, while in this condition, it strikes the body, it may inflict the most frightful injury upon the muscles, bones, and even the viscera, and yet not perhaps leave a trace of its effects upon the skin, the elasticity of which enables it to slide out of harm's way, while the other and deeper structures, which possess this property in a less degree or not at all, readily yield to its influence, and suffer severely in consequence.   In such an event, the patient may instantly perish from the violence of the shock ; or, if he sur- vive the immediate effects of the injury, his life will be likely to be assailed by wide- spread sloughing of the soft parts.

During naval and military engagements, soldiers often have pieces of their dress, accoutrements, and even of their persons, carried away by balls in rapid motion, without sustaining any serious injury in the bones and muscles.   The faculty possessed by the integuments of gliding out of the way of mischief is well exemplified in railway acci- dents, which strongly resemble those inflicted by partially spent round shot, and in which they frequently escape in the most astonishing manner, while the deeper parts, soft as well as hard, are frightfully torn and pulpified.   These gunshot lesions are much less frequent now than formerly, owing to the general use of the conical ball, which does its work more neatly and effectually, as well as at a much greater distance, than the old round ball.

The distribution of wounds during a battle will necessarily vary with circumstances. In an engagement in the open field, the chances are that nearly all parts will suffer alike. In nearly four hundred cases of gunshot injury which I saw after the battle of Bull Run, in July, 1861, almost all the wounds were situated in the extremities, and in nearly equal proportion in the upper and lower.   A few only of the patients had been struck on the head, chest, back, or abdomen.   This cannot, however, be taken as a fair criterion of the result of the engagement, since those that were most severely wounded fell into the hands of the enemy.   At the capture of Fort Donaldson, in February, 1861, accord- ing to the estimate of Dr. Andrews, seventeen per cent. of those wounded were shot in the head and face.   At the battle of Pittsburg Landing, at Fair Oaks, and several other places, the majority of the injuries in the Federal troops were situated in the lower ex- tremities.   According to Hennen, of the wounds received in battle, ten will be in the upper extremity, seven in the lower extremity, seven in the head, four in the neck and chest, and two in the abdomen.   Scrive, from his observations in the Crimean war, con- cludes that, in the open field, one-tenth of the wounds will be in the head, one-twentieth in the chest, and one-fortieth in the abdomen.   Men fired at behind breastworks are most liable to suffer in the head, neck, chest, shoulders, and arms, the lower parts being protected by the defences.

Symptoms.—The symptoms of gunshot wounds necessarily resolve themselves into local and general, or into such as are peculiar to the part and to the system; and, it need hardly be added, vary greatly in their character, according to the extent of the lesion, the importance of the tissues involved, and the idiosyncrasy and other circumstances of the individual.

The pain in a wound of this kind is often very insignificant, the person, although perhaps severely hurt, not being conscious of having received any injury until some minutes after it has been inflicted.   It is generally of a dead, heavy character, altogether different from the pain of an incised or punctured wound ; it is only when a large nerve has been partially cut across that it is likely to be at all severe, and then it is usually very sharp, pricking, or burning.   In this case, too, there will also be more or less numbness in the part below the wound, and sometimes, as when the principal nerve has been entirely severed, complete paralysis.   Thus, in gunshot wounds of the thigh, involv- ing the division of the sciatic nerve, there is always loss of motion, and often, also, of sensation of the knee, leg, and foot, which feel as if they were cold and dead.   The suf- fering is generally great when a bone is broken, a large joint penetrated, or a visceral cavity laid open, and the shock is then also much more severe and protracted.   The pain, however slight at the moment of the injury, is always more or less aggravated upon the supervention of inflammation.

The hemorrhage in gunshot wounds is generally not at all in proportion to the severity of the injury, owing to the contused and lacerated nature of the lesion. The structures immediately around the track of the ball are usually so much condensed that, unless the divided vessels are large, or numerous, the bleeding will, in the majority of instances, be so slight as to excite little, if any, alarm for the patient's safety. Very frequently, indeed, it amounts to the merest oozing, which soon ceases spontaneously, or under the application of cold water. If a large artery, however, has been laid open, the hemorrhage may not only be copious, but so great as to prove speedily fatal, perhaps, indeed, in a few minutes at furthest. Such an event will be more likely to occur if, as so often happens in this class of injuries, the vessel is only partially divided, so as to prevent its retraction; when this is the case the blood will flow most freely, and, although it may be temporarily arrested by syncope, the clot will be washed away the moment reaction takes place, the fainting recurring again and again until the patient has bled to death. If, on the other hand, the artery is completely severed, there may hardly be any hemorrhage whatever until the occurrence of reaction; perhaps not even until the separation of the sloughs.

During a battle it often happens that an extremity, torn off by a shell or round shot, is left hanging merely by the integuments, and yet the patient is in no immediate danger from hemorrhage, the vessels, from their lacerated and contused condition, being instantly closed by coagula.

A ball may pass directly in the course of a large artery, perhaps the main trunk of a limb, and yet the vessel escape injury, or, at most, be merely grazed. The reason of this is the resilient power of the vessel, which enables it to jump, as it were, out of the way of the projectile. Such an artery, however, will be particularly liable to gangrene, and, therefore, to secondary hemorrhage during the separation of the sloughs.

The hemorrhage is generally external, the blood issuing at both orifices of the wound. The reverse, however, may be the case, especially if the injured parts have been thrown out of their relative positions, or if, as sometimes happens, there has been extensive separation of the muscles; in such an event a large quantity of blood may be effused among the deep-seated structures, with hardly any outward bleeding. In wounds of the chest, abdomen, and pelvis, the hemorrhage is usually internal, and therefore the more dangerous, because concealed.

Gunshot wounds are, for the reasons already mentioned, extremely liable to secondary hemorrhage. A large artery may have been merely grazed, and, inflaming, a slough may form, which, separating, may, in a few minutes, give rise to severe, if not fatal, bleeding. Or an artery, of considerable size, may have been completely severed, but its ends, as well as the surrounding parts, having been violently contused, a clot is instantly formed, which thus affords a temporary barrier to the escape of blood; by and by, however, reaction takes place, and then perhaps the artery is reopened, its contents now gushing out in a full stream; or the event may not take place for some days, perhaps not until after the establishment of suppuration, ulceration, or gangrene and sloughing. Sometimes the injured vessel is completely blocked up by the ball or other foreign substance, upon the removal of which copious hemorrhage ensues.

Secondary hemorrhage, the result of sloughing, usually arises from the tenth to the fifteenth day; much, however, will depend, in this respect, upon the size of the ball and the amount of injury sustained by the soft parts around the wound, as well as by the vessel itself. In some instances it does not appear before the twentieth, twenty-fifth, or thirtieth day; and, on the other hand, it occasionally occurs as early as the fifth, sixth, or seventh.

The occurrence of aneurism, as an effect of gunshot wounds, is uncommon, especially the circumscribed variety. The diffused form is more frequent, and is generally a very grave affection, liable to be followed by violent local and constitutional suffering. Sometimes the passage of a ball leads to the formation of an arterio-venous aneurism, as in a number of instances under my observation, one, among others, of which was kindly brought to my Clinic by Dr. W. B. Atkinson, of this city.

The constitutional symptoms are subject to much diversity. The shock is sometimes severe in a degree altogether disproportionate to the violence of the injury; the stoutest and most courageous individual will often swoon from the most insignificant wound, and, on the other hand, a man may have his limb completely shattered, and yet not evince any serious alarm; his mind is perfectly calm and collected, and he is, perhaps, able to give the word of command or cheer on his comrades up to the very moment of his dissolution. Temperament and idiosyncrasy have much to do in the production of these phenomena, and should have due weight in the prognosis of the case. It is said that veterans upon

the field of battle generally, other things being equal, suffer much less apprehension and alarm from their injuries than raw and inexperienced troops.

The subjoined case affords a good example of the manner in which shock occasionally causes death in gunshot wounds in civil life :—An army officer in 1851 fell in a duel, the ball, a very large, round one, fired from a rifle at a distance of forty yards, entered the left thigh a little above its upper third, lacerating the soft parts in the most horrible manner, laying open the femoral vein, and crushing the bone into numberless fragments. The missile then passed into the right thigh, where it lodged, producing, however, but little mischief. Although hardly a pint of blood was lost, the system never rallied, notwithstanding the free use of brandy and other stimulants, up to the moment of the patient's death, two hours after the rencontre.

The shock in gunshot injuries is generally most intense when the ball traverses the head, chest, abdomen, or pelvis, when it splits, breaks, and comminutes a large bone, or when it lays open an important joint, as that of the knee or hip. A wound inflicted with a conical ball is, other things being equal, attended with more collapse than one made with the common round ball. During the Crimean war upwards of two hundred soldiers perished from shock alone within forty-eight hours after the receipt of their injuries.

Great mental agitation, sometimes followed by furious delirium, and even by insanity, has been known to ensue, within a short time after a severe battle, in soldiers who escaped all bodily injury, but experienced excessive alarm and shock the moment they reflected upon the dangers through which they had passed. A number of such cases occurred during the war in the Crimea.

It has generally been supposed that gunshot wounds are peculiarly liable to be followed by tetanus, but this is the case only when the sufferers are neglected, or permitted to lie upon damp, cold ground, or in currents of cold air, after an engagement. When they are properly cared for, the danger from this source is very trifling. Thus, after the affair in Paris, in July, 1830, of three hundred and ninety wounded received into the Hôtel-Dieu, of that city, only one was attacked with tetanus. In the Peninsular war the proportion was estimated at about one in two hundred ; and in the Schleswig-Holstein campaigns, according to Stromeyer, at one in three hundred and fifty. In the English army in the Crimea, the number was exceedingly small, being only 0.2 per cent. of the wounded ; and the French loss, during the same period, did not exceed altogether thirty cases. After the battle of Solferino, three deaths occurred from this disease, caused chiefly, as is supposed by Bertherand, by the damp, chilly air of the churches in which the wounded were temporarily accommodated. Baron Larrey was struck with the great frequency of tetanus in Egypt, especially in the neighborhood of the Nile and the sea. The mortality from tetanus after naval engagements is sometimes very great. Thus, after Admiral Rodney's action, twenty out of eight hundred and ten wounded were attacked with this disease ; and during our war with Great Britain the proportion was still more frightful. Injuries inflicted upon the hand and fingers by the toy pistol are a frequent source of tetanus. In Baltimore, in 1881, nearly twenty persons, chiefly boys, died from lesions of this kind inflicted during the Fourth of July celebration.

Prognosis.—The prognosis of gunshot wounds varies with so many circumstances as to admit of being pointed out only in a very general manner. Some of the milder cases of this class of injuries often recover promptly, without a solitary untoward symptom, the parts occasionally uniting, as I have myself seen in several instances, by the first intention. In other cases, on the contrary, apparently of a mild character, severe nervous symptoms may arise, or the wound may take on erysipelas, or a bad form of inflammation, and the patient lose his life. In 1857, I attended a young man who had been shot with a pistol, the ball, a small one, having entered the outer and back part of the arm, just above the middle, grazing the humerus, and lodging immediately under the integument, from which I removed it an hour afterwards. The ordinary treatment was employed ; but in thirty-six hours violent erysipelas set in, and death occurred in less than eight days from the time of the injury. On the other hand, apparently the most desperate cases will sometimes recover. Much will, of course, depend, in every instance, upon the size and situation of the wound, the presence or absence of complications, the state of the patient's constitution, the condition of the atmosphere, and the nature of the treatment. Wounds inflicted in battle are generally more fatal than those received in civil life, especially if treated in crowded, ill-ventilated hospitals. Death then often occurs from sheer neglect, or the want of good nursing and suitable surgical treatment.

Some gunshot wounds must necessarily be fatal, either instantaneously, as when they involve a large vessel, or an important organ, or, more or less remotely, as a consequence

of inflammation, gangrene, pyemia, or profuse and exhausting discharge. The danger to limb, if not to life, will be great when a large joint has been laid open, the main artery, vein, or nerve severed, the bone crushed, or the integument extensively stripped off; or when all, or nearly all, of these parts suffer together. Gunshot wounds of the lower extremity are, other things being equal, more dangerous than those of the upper, sharing, in this respect, the same fate as ordinary lacerated and contused wounds.

The causes of death in gunshot wounds are, shock, hemorrhage, pyemia, erysipelas, gangrene, tetanus, profuse suppuration, and hectic irritation.

Remote Effects.—The remote effects of gunshot wounds are often very troublesome, entailing much suffering, and being occasionally followed by loss of life at the distance of many years. In a case of gunshot injury of the chest, related by Dr. M. H. Houston, of Virginia, a thick linen patch, with which the ball had been enveloped, remained in the left lung for twenty years, when the patient died in a state of extreme marasmus, his general health having never been good since the occurrence of the accident. Sometimes a bullet lodges in the head of a bone, where, although it may for a while be comparatively harmless, it ultimately causes necrosis, with inflammation and discharge in the soft parts, thus necessitating the removal of both substances, if not of the limb itself. Marshal Moncey died from the effects of a gunshot wound forty years after its receipt.

In 1861, I removed from the lower part of the leg of a man seventy-nine years of age, shot at the battle of Moscow, a ball weighing six drachms and a half; it was incased in a mass of calcareous matter, and, although it was somewhat rough on the surface, it had remained in a quiet state for forty-nine years, when it gave rise to inflammation, followed by some pain and profuse discharge, necessitating surgical interference. An old soldier, wounded at the battle of Chippawa, carried a half ounce bullet in the upper part of his thigh for sixty-one years. During all this time, however, he suffered more or less from pain and suppuration.

On the other hand, a ball may occasionally remain in the body for a long time, perhaps even in an organ of vital importance, without inducing any particular mischief. Thus, in a case reported by Dr. Henry Wurtz, of New York, an ounce bullet was found, on dissection, in the middle lobe of the right lung, of an old soldier, forty-five years after its introduction at the siege of Badajos. It was inclosed in a distinct cyst, an inch below the surface of the organ, having entered between the fourth and fifth ribs, as was proved by the existence there of an old cicatrice. An Englishman lived, without any inconvenience, with a ball in his back between his shoulders for fifty-six years. Dr. S. W. Gross has recorded the case of a soldier, struck at the battle of Shiloh, in which a cylindro-conoidal ball was encysted in the right cavernous body of the penis.

In gunshot injuries, attended with fracture, it is not uncommon for the wound, after having become apparently perfectly solidified, to reopen, and take on unhealthy action. The cause of this occurrence is usually some foreign substance, generally a piece of dead bone, imprisoned by callus, which, for a time, masks its presence, but does not ultimately prevent it from exciting inflammation and suppuration. More frequently the wound, under such circumstances, remains fistulous until the source of the irritation is completely removed.

Among the more serious remote effects of this class of injuries are, atrophy of the affected limbs, paralysis, either partial or complete, permanent ankylosis, and contraction of the tendons, muscles, and aponeuroses, leading to deformity and loss of function.

Treatment.—In the treatment of gunshot wounds six distinct indications are presented: 1st. To revive the patient, or promote reaction; 2dly. To arrest hemorrhage; 3dly. To ascertain the precise condition of the soft parts and bones; 4thly. To extract the ball and any other foreign matter that may have entered along with it; 5thly. To remove any loose pieces of bone; and 6thly. To circumscribe the resulting inflammation.

1st. *Shock* is relieved by the employment of the ordinary restoratives. If the patient be faint, he must at once be placed in the recumbent posture, with his head as low as the rest of his body; cold water must be dashed upon the face, the fan freely used, and the smelling-bottle passed under the nose. If the symptoms are urgent, sinapisms are applied to the chest, spine, and extremities, a stimulating injection is thrown into the bowel, and, if the power of deglutition is not gone, brandy, wine, or ammonia is given by the mouth. If, however, there is internal hemorrhage, care is taken to bring up the pulse slowly and gently, allowing time for the formation of coagula, and guarding against the occurrence of violent inflammation. A kind look, or a soothing expression, will often do more to revive the patient and encourage recovery than anything else.

2dly. If the *hemorrhage* be capillary, or caused by the division of very small vessels,

it will probably soon cease of its own accord, or simply by exposure of the part to the cold air, or under the application of cold water, pounded ice, or some astringent lotion. If it be venous, compression may perhaps suffice; whereas if it proceed from a large artery, such as the radial or tibial, the only reliable remedy is the ligature. The case is very simple when the vessel is superficial, and the wound capacious; but, under opposite circumstances, the duty of the surgeon is often exceedingly embarrassing. Here it becomes necessary either to dilate the wound, so as to expose the artery and tie it at both ends, which is by far the best plan; or, when this is impracticable on account of the depth of the vessel, its proximity to important structures, or the great swelling and infiltration of the parts, as may happen when some time has elapsed since the receipt of the injury, to cut down upon the main trunk of the vessel, and to secure it as in the Hunterian operation for aneurism. The latter procedure, however, will rarely succeed, inasmuch as the bleeding is extremely liable to be kept up by the recurrent circulation; for this reason it is always best, if practicable, to expose the injured artery at once, and to apply a ligature to each extremity, which cannot fail to put an effectual stop to the flow of blood. The more promptly the operation is performed the better; if the surgeon wait till inflammation has supervened, great difficulty will be experienced, not only in securing the artery, but also in inducing the ligature to maintain its hold upon its softened and partially disorganized tissues. When the hemorrhage has been very profuse, but has gradually or suddenly stopped, it will hardly be safe to intrust the case to the efforts of nature, because, when reaction occurs, the vessel will almost be sure to be reopened, and thus the bleeding may progress until the system is completely exhausted; whereas, if the surgeon has done his duty, the parts will be placed in the best possible condition for speedy recovery. The proper plan in such cases is to do whatever may be necessary without temporizing.

When secondary hemorrhage is expected, as when a ball has passed in the direction of a large artery, the patient should be most sedulously watched until all danger is over. A tourniquet should be placed loosely round the affected limb, and instructions given to tighten it the moment bleeding appears. Meanwhile the patient should be kept perfectly quiet, and everything done to control vascular excitement. If the wound is not too large, it may, as an additional precaution, be plugged with lint soaked in Pagliari's styptic or in a strong solution of subsulphate of iron.

Aneurism caused by gunshot injury must be treated in the same manner as in ordinary cases of this disease; if possible, by ligation of the affected vessel; if this fail, and the symptoms are urgent, by amputation.

3dly. To ascertain the *condition of the wound* is a matter of the first importance, and yet it is one which, I am convinced from much personal observation, is often most grossly neglected. The object should be not only to determine whether there is any foreign substance, but what the actual condition of the soft parts and bones is; whether, in a word, excessive and irreparable injury has been inflicted, forbidding all attempts at surgical interference, whether primary amputation is demanded, or whether the treatment should be wholly conservative. For the want of this precaution many limbs and lives are lost, simply because what should be done at once, at the earliest possible moment, is postponed until it is too late to be of any benefit. Many of the men that are sent from the battle-field to the hospital fall victims to erysipelas, pyemia, gangrene, and secondary hemorrhage in consequence of the irritation produced by retained splinters of bone, shreds of clothing, or other hurtful matter that should have been extracted on the spot. Such neglect, whether caused by ignorance, carelessness, or timidity, cannot be too pointedly condemned, or too severely censured. It need hardly be added that, inasmuch as all explorations of this kind must be painful, the patient should always be thoroughly anæsthetized. Moreover, they should be instituted at the earliest possible moment, before the parts are invaded by inflammation and swelling, as they may then be conducted with comparative ease, and without any serious ulterior harm.

4thly. The fourth indication is the *extraction* of the ball; but to do this it is necessary, in the first place, to ascertain where it is; to grope about in the wound without any definite idea as to its precise location, would only be to inflict additional pain and injury. In order to conduct the examination with the greatest advantage, the part should be put as

Fig. 109.

Author's Bullet Probe.

nearly as possible in the position in which it was at the time of the accident. This is the more necessary, because, as was before stated, the missile often pursues a very different route from what might be supposed from merely looking at the orifice of entrance or exit ; the slightest resistance may change its direction, and cause it to lodge at a point far beyond what it would have sought, had it been permitted to pass in a straight line. Hence attention to the position of the part is, in all cases, a matter of the greatest importance.

Fig. 110.

Sir Charles Bell's Bullet Probe.

In searching for the ball, care must be taken not to mistake for it some osseous prominence. Stromeyer refers to two cases in which he saw this blunder committed : in one the surgeon cut down upon the head of the fibula, in the other upon a metatarsal bone. The assertion of a patient that the ball has dropped out is seldom reliable, unless the missile is found in his pocket.

The course of a ball is sometimes indicated by the impression made by it upon the nerves of the part. Thus, as observed by Sir Charles Bell, when the missile has traversed the pelvis or shoulder, the defect of feeling in the extremity, studied anatomically, will afford useful information in regard to its passage ; whether, for example, it has cut, or is pressing upon, a particular trunk. The color of the blood will indicate whether an artery or vein has been wounded, and the size of the stream whether the vessel is small or large.

The best probe for conducting the examination is the finger, provided it is sufficiently long and slender ; it possesses the same value, in such cases, as direct auscultation in the exploration of the chest, or the finger in the examination of the uterus and rectum, and should, therefore, always be used when practicable. If the digit is inadequate, recourse is had to a stout probe, fig. 109, or fig. 110, from ten to twelve inches in length, as thick as a medium-sized bougie, slightly flexible, blunt-pointed, and composed either of silver or brass. The ordinary pocket probe is much too small. When a suitable instrument is not at hand, the necessary exploration may be performed with a female sound or catheter, or even with a long, slender pair of bullet forceps. The instrument, whatever it may be, is passed along the track of the wound with all possible care and gentleness, otherwise it will be very likely to make a false passage in the surrounding connective tissue, or become entangled among the muscles, tendons, nerves, or vessels. The contact of the probe with the ball usually produces a sensation of roughness and resistance, together with a dull noise if the instrument be struck against the foreign body by short jerks.

When it is doubtful whether the missile has really lodged, or when the missile is retained, but cannot be distinguished from bone, Nélaton's probe, consisting of a metallic rod, the extremity of which is tipped with a small olive-shaped piece of white, unpolished porcelain, capable, when rubbed against a bullet, of receiving a stain from it, will afford the most satisfactory result. The instrument being withdrawn, any blood or pus that may have collected upon its bulb should be washed off with a stream of water, in order that the stain, if any exist, may be brought into full view. When such a probe is not at hand, a good substitute will be found, as suggested by Dr. Gelisch, of California, in one constructed of white pine wood, the extremity of which readily receives the stain of the lead.

Attempts have been made from time to time to detect the presence of bullets by the use of the electric bell-probe, but in hardly a solitary instance with satisfactory results. What future investigations may accomplish in this direction remains to be determined.

Finally, the missile may sometimes be detected with the exploring needle, after all the more ordinary means have failed. The instrument, which should be long, straight, and slender, should be inserted at the supposed situation of the foreign body, and moved about in different directions until the diagnosis is clearly established. The peculiar shape of the missile, and the facility with which it may be displaced, provided it is not firmly imbedded, may be regarded almost as certain indications of its presence.

The bullet being found, the forceps take the place of the probe, the blades being firmly closed as they pass along the track until the point comes in contact with the extraneous substance, which is then seized and extracted in such a manner as not to include any of the surrounding tissues. Occasionally the operator will derive important aid in his manipulations from counter-pressure, the hand or the thumb and a few fingers being applied to the opposite side of the wounded parts.

Bullet-forceps and extractors, of various forms and sizes, are in use. The most important qualities of such instruments are lightness, strength, and slenderness, with length of blade, which should not be less than four inches. The extremity should be well rounded

Fig. 111.   Fig. 112.   Fig. 113.   Fig. 114.   Fig. 115.
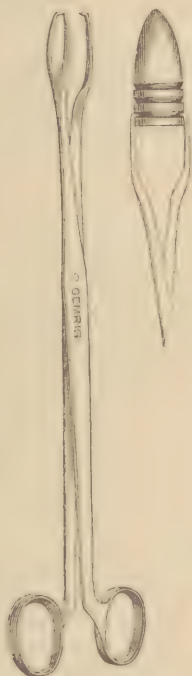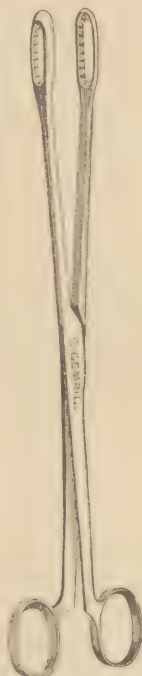
Thomassin's Forceps.   Gemrig's Forceps.   Fenestrated Forceps.   Bullet Extractor.   Thomassin's Extractor.

off, and fashioned in such a manner as to adapt itself readily to the shape of the foreign body, and at the same time grasp it with great firmness, without the risk of including any of the adjacent structures. The old forceps did good service during the reign of the round ball, but will hardly answer for the extraction of the conical. For the latter purpose, Mr. Tiemann, of New York, has reintroduced to the notice of the profession the ingenious instrument, fig. 111, devised by Thomassin in the latter part of the last century. It is quite slender in the blade, and is provided with short, stout teeth, projecting somewhat like the incisors of a mouse, their object being to take a firm hold upon any part of the bullet by partially burying themselves in its substance.

Thomassin's instrument has been greatly improved by Mr. Gemrig, by making the end of one blade cup-shaped, with two curved prongs, separated in front by a narrow interval, and terminating each in a point. The other blade has only one prong, also curved, but central, and terminating in a point, which, when the forceps are shut, is received in the interval here alluded to, thus rendering its extremity perfectly blunt. The instrument, represented in fig. 112, answers for the round as well as the conical ball, and possesses the great advantage of facility of application with firmness of grasp.

The forceps delineated in fig. 113 were made in 1861 at my suggestion, by Mr. Gemrig. They are about nine inches and a half in length, light, slender and fenestrated at the extremity, which is scooped out in such a manner as to embrace the ball with great facility, while its inner surface, roughened like that of a stirrup, maintains its hold with extraordinary firmness.

When the wound is unusually large, and the ball not deeply seated, the extraction may sometimes be effected with a small lithotomy scoop, the common dressing or polyp forceps,

or an instrument like that sketched in fig. 114, made for me by Mr. Kolbe. It consists of a silver tube, inclosing a steel stylet, terminating in two blades, cup-shaped on the inside, and movable by a hinge. The extremity of the instrument is seen grasping the ball. Fig. 115 represents a similar instrument, devised by Thomassin, and used by the French and British surgeons. When the course of the ball is very circuitous, or when the missile is imbedded among swollen and infiltrated tissues, advantage may be derived from the elastic forceps of Dr. Weisse, delineated in fig. 116.

Fig. 116.

The gimlet-like instrument, so much extolled by the older surgeons, is now almost obsolete, although it might still occasionally be employed with advantage when the extraneous substance is lodged in a bone thickly covered by muscles. The trephine, however, is generally preferred under this and similar circumstances.

The extraction of a ball and other foreign matter is sometimes greatly facilitated by the elastic roller, or the ordinary bandage, tightly applied. It is especially valuable when the wound is situated among very vascular structures, or when deep incisions are required for the detection or removal of the missile.

A ball, after having traversed the thickness of a limb, or of the body, occasionally lodges immediately beneath the skin or among the superficial muscles, where its presence may readily be detected by the probe or finger. In such a case it should be removed by a *counter-opening*, made by cutting down upon it at the nearest point; a procedure which often saves an immense amount of pain and trouble.

When the ball cannot be found without much probing, and the risk of inflicting serious additional mischief, the best plan is to let it alone, in the hope that it may either become encysted, or that it may be detached and washed away by the discharges. In general, however, every justifiable effort should be made to remove it, on the ground that, if left, it will be almost sure to excite violent inflammation, followed by profuse suppuration and extensive separation of the tissues. Such an event will be more likely to occur when the ball has become rough, jagged, or flattened by striking against a bone; for then it must necessarily keep up irritation so long as it remains, as there is no possibility of its being isolated by an adventitious membrane.

The great importance of not permitting balls to remain unextracted has been placed in a very forcible light by the observations of Hutin, chief surgeon of the Hôtel des Invalides of Paris. Of 4000 soldiers whom he examined, within a space of five years, only 12 had experienced no inconvenience from the retention of foreign bodies, while the rest, 200 in number, had all suffered more or less severely until they were relieved by operation.

Another reason for the early extraction of the missile is that persons soon after the receipt of the injury, generally, submit much more readily to the necessary operation than after they have partially recovered from its effects; their dread usually increases in proportion as they get well, and thus pass beyond the reach of immediate danger.

Weisse's Elastic Forceps.

When a ball lies loose in a movable joint, it should always be promptly extracted; if, on the other hand, it is lodged in an adjoining bone, the proper plan is to let it remain, in the hope that it may soon be covered with plastic matter, and thus become comparatively harmless. The only exception to this rule is where the ball projects into the cavity of the articulation, when it should be removed at all hazards, inasmuch as its retention would inevitably lead to violent, if not fatal, inflammation, and utter uselessness of the part.

No sensible surgeon ever thinks of searching for a ball in any of the great cavities of the body; such a procedure would be sure greatly to increase the dangers of the accident, and cannot, therefore, be too pointedly condemned.

If it be necessary to the welfare of the part and system to remove a ball, which is a comparatively innocuous substance, it is much more important to extract the various *foreign bodies* which so often enter along with it, and the presence of which, however protracted, must be a source of incessant irritation and annoyance. The rule here is imperative, and applies to the smallest as well as to the largest substance ; to the little piece of wadding and the stoutest splinter, the linen shred and the brass button ; in short, to every description of extraneous matter. Wherever it may be, it must be sought for, and, if possible, extracted without delay. There is no chance here for the formation of a cyst, as sometimes happens with a ball ; nature admits of no such liberty. In naval and military engagements large pieces of wood, metal, and other substances are liable to be impelled into the body, in which they are often buried at a great depth, or lodged among the muscles, which sometimes close over them in a sort of valve-like manner, rendering it extremely difficult not merely to extract but even to find them. Much may be done in such cases by the gentle use of the finger and probe, aided by counter-pressure.

5thly. Any detached *splinters* of bone, or pieces of bone so much loosened as to render it improbable that, if left, they will reunite, should be removed as early as possible after the occurrence of the accident, experience having shown that their retention is always productive of extensive and protracted suppuration, if not of worse results. By the timely extraction of such bodies, immense suffering may be prevented, and ultimate recovery greatly expedited. It is surprising that surgeons should ever hesitate in such a case, and yet the instances are not uncommon of the most culpable neglect. A remarkable example of this kind fell under my notice in 1847, in Lieut. George Adams, of the United States Marine Corps, who was desperately wounded in the right thigh by a large musket ball, at the battle of the National Bridge, during our war with Mexico. The soft parts were extensively injured, and the bone shattered into numerous fragments, not less than twenty-four of which, some of them upwards of an inch and a half in length, I removed nine months afterwards, from the enormous callus that had formed around the seat of the fracture : most of them were completely imprisoned in the new osseous matter, and, therefore, very difficult of extraction. The incisions healed kindly, except at one point, which refused to close, owing to the presence of a small piece of bone, which was subsequently removed by the late Professor Warren, of Boston.

When *powder* is imbedded in the skin, every particle should immediately be picked out with a cataract needle, or a delicate bistoury, entirely regardless of pain. Unless this be done, the powder will speedily excite inflammation, besides causing disagreeable and permanent disfigurement by the bluish spots which it will leave. The operation is not only tedious, but always attended with severe suffering. The resulting inflammation is to be combated in the usual manner ; cold water, or cold saturnine lotions, being generally the best local remedies.

6thly. The last indication is to circumscribe and moderate *inflammation*. To fulfil this, attention to various points is necessary. In the first place, the parts must be properly dressed. The rule formerly laid down was that the orifices of the wound should be lightly covered with lint and adhesive plaster. Such a procedure is exceedingly irrational, inasmuch as its direct effect must inevitably be to aggravate the local mischief by interfering with the discharges, of which there will necessarily always be more or less. Instead of this, the orifices should be left open, while, by means of a light compress and bandage, an attempt is made to approximate the sides of the wound in order to promote their reunion. The roller, extending from the distal portion of the limb beyond the seat of injury, must be applied in such a manner as not to impede drainage. By such treatment the cure will often be immensely expedited ; the resulting inflammation will be comparatively slight, infiltration of fluids will, in great degree, be avoided, and suffering will be vastly abridged. The bandage, however, must be used with great caution, for there is danger, especially when there is much swelling, of its producing injurious compression, and thus becoming a cause of gangrene. In gunshot wounds of the extremities, involving the deep muscles and aponeuroses, great advantage will accrue, during the progress of the treatment, from the use of the bandage in preventing the formation of sinuses and in favoring the escape of pus.

The part having been dressed, and placed at rest in an easy, elevated position, cold water is applied, provided there is no contraindication to its use, on account of the state of the weather or the intolerance of the part and system. If the weather be mild, and the patient young and robust, cold will usually be borne better than warmth, and the most eligible form is that of water, either simple, or medicated with opium and acetate of lead. The use of cold water in the treatment of this class of lesions dates as far back as

the time of Biondo, towards the middle of the sixteenth century, and its beneficial effects, although lost sight of for a long time, were again brought prominently before the notice of the profession by Kern, Larrey, Guthrie, and other army surgeons, during the continental wars of Europe early in the present century. Cold water, however, is not tolerated equally well by all patients, and the rule, therefore, is, when it disagrees, to substitute warm applications, either in the form simply of tepid water, or in that of a light, emollient cataplasm, which, after all, makes, in many cases, an admirable dressing, soothing pain, and promoting discharge.

Although water-dressing usually answers a most excellent purpose in this and other classes of wounds, I am certain, from long experience, that its efficacy may generally be very greatly increased by the addition of acetate of lead and opium, the astringent and anodyne effects of which are thus directly imparted to the affected structures. An ounce of the former of these articles with a drachm of the latter to a half gallon of boiling water are the proportions which I commonly employ. The application is made either tepid, cool, or cold, as may be most agreeable to the patient. During my connection with the George Street Military Hospital of this city I had ample opportunities of testing this mode of practice, and of satisfying myself of its superiority.

When much contusion exists, as is so often the case in shell and cannon wounds, the best local remedy is some spirituous lotion, as, for example, two parts of alcohol or tincture of arnica to ten of water, with the addition, if there be any offensive discharge of a small quantity of chlorinated sodium. The tissues, deprived of nervous power, must be slightly stimulated, to prevent them from running into profuse suppuration, if not gangrene.

If the inflammation assumes a threatening aspect, as when it is of an erysipelatous character, and is attended with great pain, tension, and swelling, free incisions, and sometimes counter-openings, must be made, otherwise extensive mischief may result from the burrowing of fluids, and the consequent destruction of the connective tissues. Besides, the parts, if not promptly relieved, might mortify. The older surgeons made it a rule to dilate all wounds of this kind as soon as possible after their infliction, with a view of preventing these and other untoward results, but this procedure has become obsolete, the modern practitioner resorting to it only when the necessity arises on account of the severity of the inflamation; assuming that a man ought not to be cut merely because he has been shot.

When there is profuse suppuration, with extensive separation of the tissues, the wound should be freely syringed several times daily with tepid water, slightly medicated with chlorinated sodium, permanganate of potassium, bromine, carbolic acid, nitric acid, or subsulphate of iron, the latter being particularly serviceable when there is a disposition to bleeding. Much may frequently be done in this manner, not only in preventing the lodgment and burrowing of pus, but in getting rid of any clots of blood, shreds of cloth, or detached splinters of bone that may be present.

The orifices of the wound will usually begin to granulate in from four to eight days, even when there is slight gangrene of their edges, and the whole track will often close in an almost incredibly short time. Much of it, especially if it be long, will be in the condition of a subcutaneous wound, and, therefore, highly favorable to repair. When the passage is slow in filling up, the healing process may be expedited by the use of slightly stimulating injections, thrown in twice in the twenty-four hours; few cases, however, will demand such interference. The wound of exit generally heals first, provided it is not ragged, contused, or interfered with by the discharges.

Conjoined with these local measures must be perfect rest of mind and body, along with a generous diet, gentle laxatives, and anodynes, the latter being given for the double purpose of allaying pain and spasm, and inducing sleep. Opiates are generally borne in large doses, and can rarely be dispensed with in any case, however mild. If the wound is severe, and especially if it be attended with serious hemorrhage, antimonials and active purgation must be scrupulously abstained from, on account of their depressing effects, and their tendency to provoke pyemia and erysipelas. Due allowance must be made, in every instance, for the discharges which are likely to attend such injuries. Hence much judgment is often required to steer clear of difficulty and danger. Bleeding by the lancet is hardly to be thought of under any circumstances; in young and plethoric subjects, however, blood may occasionally be advantageously taken by leeches. In ordinary cases, the diet should be plain and simple, rigid abstinence not being required, except when there is unusual fulness of habit. Marked exhaustion, whether from shock, loss of blood,

inflammatory disturbance, or profuse suppuration, must be met by the use of milk punch, quinine, iron, cod-liver oil, and nutritious food.

If any tendency to erysipelas, pyemia, or hospital gangrene arises, the patient in addition to the means already indicated, should be promptly placed under the influence of iron and quinine along with brandy and nutritious food; and if large numbers of wounded are crowded together, no time should be lost in effecting their sequestration.

The progress of gunshot wounds is often seriously interrupted by the occurrence of diarrhœa and dysentery, especially in tropical regions or in the heat of summer, among troops that have been exposed to malarious influences. The discharges rapidly reduce the strength, and often, in the course of a very few hours, completely arrest the granulating process. The best remedies are quinine and iron in union with opium and arsenic. Powdered charcoal and permanganate of potassium are also valuable remedies, either alone or variously combined with other articles, particularly anodynes. A scorbutic state of the system is best rectified with subacid fruits and vegetables, tonics, beef essence, and milk punch. In all cases the patient should have the full benefit of fresh air, frequent ablutions, and change of clothing.

When the cicatrization of a gunshot wound is fully completed, there is commonly a marked difference between the scar at the opening of entrance and that of exit. The former is generally somewhat depressed, whereas the latter is either on a level with the adjacent surface or projects very slightly beyond it.

QUESTION OF AMPUTATION IN WOUNDS.

The most horrible wounds are generally those which are inflicted by machinery in rapid motion, the passage of a railway car or the wheel of a heavy wagon, and the explosion of fire-arms, violently lacerating and contusing the soft parts, extensively crushing the bones, and perhaps opening one or more of the larger joints. In many cases, the character and extent of the mischief are apparent at first sight; in others, as when it is principally subcutaneous, it becomes so only after a most patient and thorough examination. The latter class of injuries is particularly to be dreaded, as it is often impossible, even with the greatest care, to determine the extent of the lesion. When the examination necessary to ascertain the condition of the parts is likely to be painful or protracted, commiseration for the sufferer always dictates the propriety of administering chloroform, although the anæsthesia will rarely be required to be carried to the extent of complete unconsciousness, a few full and prolonged whiffs being generally sufficient to effect the desired tolerance.

In attempting to determine the question as to whether an effort should be made to cut off or save a limb, not a little stress should be laid upon the age, habits, and previous health of the patient, the manner in which the injury was inflicted, and the number, variety, and importance of the structures involved.

Young adults bear severe accidents much better, other things being equal, than the two extremes of life, childhood and decrepitude, in both of which, but especially the latter, the power of reaction is generally very feeble, and the effect of shock and hemorrhage felt for a long time. Nevertheless, there is not a practitioner of any experience who has not occasionally witnessed striking exceptions even under these circumstances. A temperate man usually bears up under a severe wound much better than a dissipated one, and the resident of the country than the inhabitant of the crowded city; a person in ill health at the time of the accident will be likely to suffer more than one in an opposite condition. The worst class of accidents in civil practice are those inflicted by railway cars, steamboats, and steam factories, and these are often of such a nature as to require the prompt removal of the mangled and mutilated structures.

But of all the circumstances influencing the recovery of the patient, and the ability of the surgeon to save the mutilated parts, the most important, by far, is the extent of the injury, or the number and nature of the tissues involved. To place this subject in a clear and tangible light, it must be considered somewhat in detail; but, before doing so, it is proper to observe that amputation should never be performed in wounds of any kind until reaction has taken place, for, if this precaution be neglected, the additional shock which the operation would necessarily impart to the system might prove fatal, either before the patient is removed from the table, or soon after. As long as he is deadly pale, the pulse small and thready, the surface cold, and the thirst, restlessness, and jactitation

excessive, the employment of the knife is wholly out of the question. The proper treatment is recumbency, with mild stimulants, sinapisms to the extremities, and other means suited to reëxcite the action of the heart and brain. Power being restored, the operation is at once proceeded with, due regard being had to the prevention of shock and hemorrhage, the two things now mainly to be dreaded.

The advantages of primary over secondary amputation, in all severe wounds, are too obvious to require comment. Mr. Guthrie long ago ascertained that the loss after secondary operations, in gunshot injuries, was at least three times as great as after primary, and the results of his observations have been amply confirmed by the more recent experience of military surgeons. In the Crimean war, where the wounds were, for the most part, inflicted with the conical ball instead of the round, as in the cases seen by Mr. Guthrie, the difference was less marked, but still strikingly in favor of primary interference. Thus, the mortality in 690 primary amputations was 175, or in the ratio of 25.3 per cent., and 38 in 89 secondary, or in the ratio of 42.7. Intermediary amputations are, as will be explained in the chapter on amputations, of all operations of this kind the very worst.

The following circumstances may be enumerated as justifying, if not imperatively demanding, amputation in cases of wounds, of whatever nature :—

1st. When a limb has been run over by a heavy cart, crushing the bones, and tearing open the soft parts, amputation should, as a general rule, be performed, even when the injury done to the skin and vessels is apparently very slight, experience having shown that such accidents seldom do well if an attempt is made to save the limb, the patient soon dying of erysipelas, gangrene, pyemia, or typhoid irritation. The danger of an unfavorable termination is always greater in the lower than in the superior extremity.

2d. No attempt should be made to save a limb when, in addition to serious injury inflicted upon the integument, muscles, or bones, its principal artery, vein, or nerve has been extensively lacerated, or violently contused, as the result will be likely to be gangrene, followed by death.

3d. A lacerated, punctured, or gunshot wound penetrating a large joint, as that of the knee or ankle, and accompanied by comminuted fracture, or extensive mischief of the ligaments, will, if left to itself, be extremely liable to terminate in tetanus, mortification, or pyemia, and is, therefore, as a rule, a proper case for early amputation.

4th. Gunshot wounds attended with severe comminution of the bones, the fragments being sent widely around among the soft parts, lacerating and bruising them severely, generally require amputation, especially in naval and military practice. Gunshot fracture of the thigh-bone is generally considered by military surgeons as a sufficient cause for primary amputation. The rule, however, admits of many exceptions.

5th. Extensive laceration, contusion, and stripping off of the integument, conjoined with fracture, dislocation, or compression and pulpification of the muscles, generally demand the removal of a limb.

In all severe lacerated and contused wounds, whether induced by cannon shot, falls, blows, machinery in rapid motion, or the passage of the wheel of a wagon, the limb should generally be amputated at a considerable distance above the apparent seat of the injury. If this precaution be neglected, mortification will be liable to seize upon the stump, owing to the fact that, in such cases, the injury, both of the soft and hard parts, usually extends much further than the naked eye can discover.

Should amputation be performed when a limb, the subject of a severe wound, laceration, or contusion, has been suddenly seized with mortification, manifesting a rapidly spreading tendency, extending, perhaps in a few hours, up as far as the middle of the leg, or even as high as the knee? Such cases are generally desperate; no local or internal remedies can arrest the morbid action; the system has sustained a profound shock, and the affected parts perish, not by inches, but literally by feet. I have repeatedly seen this variety of gangrene extend from the toes, instep, or ankle as far as the hip-joint in less than thirty-six hours, in cases where there was but little visible injury, the mischief being evidently deep-seated, involving muscle, nerve, vessel, and bone. If amputation is not performed, the disease, the march of which is indicated by a bluish, purple, or livid, crepitating, and tender streak along the limb, will be sure to terminate fatally in a few days, and the operation should, therefore, be resorted to at the earliest possible moment, the surgeon not waiting for a line of demarcation, which cannot take place, since neither the part nor the system has the power of arresting the morbid action. The event, it is true, will generally be unfavorable, but as it is the only chance the patient has, he should,

slender though it be, undoubtedly have the benefit of it.   In the cases in which I have amputated under these unpropitious circumstances, the result in all except three was fatal.

Lacerated, contused, and gunshot wounds are often of so frightful a nature as to render it certain, even at a glance, that the limb will be obliged to be sacrificed in order to afford the patient a better chance for preserving his life.   At other times, the injury, although severe, may yet, apparently, not be so desperate as to preclude, in the opinion of the practitioner, the possibility of saving the parts, or, at all events, the propriety of making an attempt to that effect.   The cases which may reasonably require and those which may not require interference with the knife are not always so clearly and distinctly defined as not to give rise, in very many instances, to the most serious and unpleasant apprehension, lest we should be guilty, on the one hand, of the sin of commission, and, on the other, of that of omission; or, in other and more comprehensive terms, that, while the surgeon endeavors to avoid Scylla, he may not unwittingly run into Charybdis, mutilating a limb that might have been saved, and endangering life by the retention of one that should have been promptly amputated.   It is not every man, however large his skill and experience, that is always able to satisfy himself, even after the most profound deliberation, what line of conduct should be pursued in these trying circumstances; hence the safest plan for him generally is to procure the best counsel that the emergencies of the case may admit of. But, in doing this, he must be careful to guard against procrastination; the case must be met promptly and courageously; delay even of a few hours may be fatal, or, at all events, place limb and life in imminent jeopardy.   Above all, proper caution must be used if the patient is obliged to be transported to some hospital, or to a distant home, that he may not be subjected to unnecessary pain, exposed to loss of blood, or carried in a position incompatible with his exhausted condition.   Vast injury is often done in this way, by ignorant persons having charge of the case, and occasionally even by practitioners whose good sense should be a sufficient guarantee against such conduct.   The transportation of a patient to a distance of perhaps hundreds of miles upon a railway car, after he has been desperately wounded, in the hope, it may be, of obtaining better aid, cannot be too severely reprehended, as involving not only the loss of precious time, but often also the infliction of additional injury upon a part and system already overwhelmed by shock and hemorrhage.

Excision in gunshot and other injuries involving the articulations is, as will be more fully explained elsewhere, applicable chiefly to the shoulder and elbow joints, in cases unattended with serious lesion of the soft parts.   In the former, a portion of the humerus, embracing, if necessary, from three to five inches in length, together with a part or even the whole of the glenoid cavity of the scapula, may be safely and expeditiously removed under such circumstances, and yet the patient have an excellent use of his arm.   Experience shows that primary excision of the other joints, excepting, of course, the smaller ones, as those of the hand and foot, is generally very unfavorable.

Further observations upon this subject will appear in the chapters on amputation, fractures, dislocations, and excisions.

SECONDARY EFFECTS OF WOUNDS AND CONTUSIONS.

Every practitioner occasionally meets with cases of wounds and bruises in which the patient, happily escaping from the primary effects of the injury, suffers severely from what may be termed the secondary effects, coming on several weeks or months afterwards. These lesions have not received sufficient attention from systematic writers.   It has fallen to my lot to see a very large number of such cases, of which the following are selected in illustration of the subject:—

A farmer, thirty years of age, twisted and bruised his left foot in a fall from his horse. The accident was instantly followed by severe pain, and next day by excessive swelling, which, however, gradually subsided under the usual antiphlogistic remedies.   In the course of a few weeks the man was able to exercise on crutches, but the foot was now observed to be very sore and tender, cold, clammy, withered, benumbed, and completely destitute of power.   There was also frequent twitching of the three small toes, particularly at night, so as to interfere with sleep.   These symptoms were aggravated in damp, cold states of the atmosphere, when there were also occasionally neuralgic pains in the part.   The general health likewise materially suffered, the appetite being bad, the bowels irregular, and the mind much dejected.   When I saw the patient, nearly a year after the accident, he had been subjected to various plans of treatment, with hardly even any

temporary relief. Notwithstanding that he was placed upon tonics, alterants, and the hot and cold douches, with frictions with veratria liniment and the use of the bandage, many months elapsed before he experienced much benefit, and he has never entirely recovered the functions of his foot and ankle.

A man, twenty-five years of age, cut himself with an axe on the instep of the left foot, directly over the internal cuneiform bone. The weapon penetrated the bone, and evidently severed the extensor tendon of the great toe, as the toe could no longer be moved by the effort of the will. The wound healed completely in a few days, but shortly afterwards the parts became tender and remained so for several months. Meanwhile, the foot and leg grew sensibly thinner, and were habitually cold and clammy; a condition which has continued for several years. Whenever exercise is taken, the parts swell, and become tender. The muscles of the whole limb are flabby and wasted. The general health is much disordered; the man has lost thirty pounds of flesh, and he has been unable to attend to any business since the accident. His tongue is habitually coated, he sleeps badly at night, and he is subject to frequent fits of despondency.

A man, thirty-five years of age, consulted me on account of an accident similar to the above. He was a bricklayer by occupation, and had always been in good health until eight months previously, when he cut himself with a hatchet in the left instep, immediately over the internal cuneiform bone, as nearly as possible in the same situation as in the preceding case. The wound healed rapidly, but the patient soon began to experience exquisite pain and tenderness in the parts, extending up the leg, and subject to severe exacerbations from damp states of the atmosphere, exposure to cold, and derangement of the digestive organs. The suffering, which was irregular in its recurrence, was generally worse at night. The limb was cold and clammy, as well as much emaciated, and the parts immediately around the scar were hard, as if from the presence of organized lymph. The general health was much impaired, the tongue was coated, and the sleep was usually much interrupted, by spasm of the limb. A prominent symptom in the case was great soreness in the hollow of the foot, in front of the heel. When the man attempted to walk, the foot became very tender, and immediately began to swell. In this, as in the preceding case, the patient was obliged to use crutches.

A young lady, who had long suffered from dyspepsia and great nervousness, punctured the forepart of her right wrist, towards the ulnar margin of the forearm, with a small, slender sewing-needle, which entered the skin directly over the ulnar artery; and passed, apparently, obliquely inwards and outwards towards the centre of the joint, without, however, penetrating it. The needle was immediately withdrawn, but not examined, and the patient, consequently, was uncertain whether a portion had not broken off and remained behind. The accident was followed by most excruciating pain, pervading the entire extremity from one end to the other, but particularly severe at the seat of the injury and in the thumb and first two fingers. A violent rigor soon succeeded, and for ten days the patient suffered the most horrible torture, being frequently threatened with tetanus, and constantly annoyed with spasmodic twitches of the muscles of the hand and arm. Considerable swelling arose shortly after the receipt of the injury in the forearm, wrist, hand, thumb, and the fingers above named. At the end of the tenth day a small, circumscribed abscess formed at the site of the puncture, which, upon being opened, discharged about a drachm and a half of thick pus, much to the relief of the patient. In a week the matter had reaccumulated, and the part was again lanced, followed by the same relief as before. Subsequently the skin was scarified several times, the cuts bleeding profusely, but not yielding any pus. During the following summer she experienced severe and constant pain, especially in the anterior part of the arm, between the elbow and the insertion of the deltoid muscle; it was always more violent in the evening, and was of a dead, heavy, aching character. The limb was stiff and numb. Her hand and thumb, together with the fore and middle fingers, swelled every evening, becoming stiff and sore, so that she could with difficulty flex or extend them. During the day the parts always felt much more comfortable. Pressure at the seat of the puncture caused a sense of uneasiness rather than of pain, but was always followed soon after by so much distress as to prevent sleep during the succeeding night. The ring and little fingers were free from swelling, and easily moved. The whole limb was cold and considerably wasted. The probability is that, in this case, the needle pricked the ulnar nerve at the wrist, producing a condition, in her bad state of health, similar to that which occasionally results from the puncture of a nerve in bleeding at the arm. Under the use of an alterative and tonic course of treatment, with strychnia and arsenious acid, the hot and cold douches, frictions with veratria ointment, a nutritious diet, and exercise in the open air, the general

health rapidly improved, and the local suffering finally disappeared, although the limb never recovered its original powers.

Bad effects not unfrequently follow upon gunshot wounds; they present themselves in different forms and degrees, and often entail great suffering along with partial loss of function. Among the more common and annoying of these secondary effects are, as before stated, neuralgic pains and a sense of numbness in the parts, progressive atrophy of the muscles, contraction of the aponeuroses and tendons, and ankylosis of the joints.

In regard to the treatment of these secondary lesions, it is impossible to lay down any definite plan; every case must be managed according to the peculiarities of its symptoms. Much benefit may generally be expected from attention to the state of the general health, which is nearly always more or less seriously disordered. Neuralgic pains, altered sensibility, and atrophy usually require a course of tonics and arsenic, purgatives, the hot and cold douches, massage, or dry frictions, the use of the fringed towel, electricity, and other means to excite the vasomotor nerves. Rigidity of the joints must be counteracted by passive motion and sorbefacients; contraction of the tendons and aponeuroses by the use of splints and the bandage, aided, if necessary, by the knife. Change of air and sea bathing are often of signal benefit.

SECT. X.—POISONED WOUNDS.

Under this head are included four distinct classes of wounds: first, those inflicted by venomous insects and snakes; secondly, those caused by the bite of rabid animals; thirdly, those produced by inoculation with the poison of glanders; and, lastly, wounds received in the examination of dead bodies, constituting what are called dissection wounds.

1. WOUNDS INFLICTED BY POISONOUS INSECTS.

There are various genera of insects which naturally secrete a poison, which, when instilled into the living tissues, is capable of producing serious and even fatal consequences. Of these the most common, at least in this country, are the humble-bee, honey-bee, wasp, hornet, and yellow-jacket. The poison of these insects is contained in a small vesicle in the abdomen, and is under the control of a peculiar muscular apparatus by which it is injected into the puncture made by the barbed sting of these little creatures. It is highly acrid, especially in the honey-bee, hornet, and yellow-jacket, transparent, of a sweetish taste at first, but afterwards hot and disagreeable, and particularly active during the heat of summer. When angry, these insects sting with great fury, producing a wound which is instantly followed by a sharp, pungent, itching pain, and in a few moments after by a pale, circumscribed, inflammatory swelling. In some persons, owing to idiosyncrasy and other causes, the symptoms are exceedingly severe and even alarming, the patient having dimness of sight, vertigo, nausea, palpitation, and a feeling of indescribable oppression, with a disposition to syncope. Instances have occurred of persons having been stung to death by a single honey-bee; one such case, of which I have the particulars, occurred, many years ago, in Kentucky, in a man upwards of thirty years of age. He was wounded in the face, and died in a few hours. A young man, an acquaintance of mine, always suffers from severe sickness of the stomach and great nervous depression when stung by a bee. Violent effects sometimes proceed from the sting of a bee, wasp, or yellow-jacket in the fauces, œsophagus, or stomach, as when these insects are accidentally swallowed in cider and other drinks.

As the sting is often left in the skin, in the infliction of this class of wounds, the part should be carefully examined, in order that, if present, it may at once be extracted. The most promptly efficacious applications are generally salt water, alcohol, laudanum, vinegar, hartshorn, spirit of camphor, Cologne water, soap liniment, solutions of acetate of lead, dilute tincture of iodine, and tobacco-juice. Turpentine is also a very valuable remedy. Whether these and similar articles act by neutralizing the poison, or merely by relieving inflammation, is not ascertained. When the system becomes affected, internal stimulants, of which the best are brandy and ammonia, should immediately be used. If the insect has passed into the throat, a mustard and salt emetic will be the proper remedy, followed, if urgent swelling and impending suffocation ensue, by leeches to the neck, and, perhaps, by laryngotomy.

Various species of the *mosquito* tribes are poisonous, and, therefore, capable of inoculating the wounds made by their bite. In the Southern States, as well, indeed, as in some of the Western, and along many parts of the Atlantic coast, the mosquito exists in

vast numbers, and often inflicts serious injury, both upon man and animals. I have met with a number of instances in which the bite of this insect was productive of severe inflammation, and several in which it was followed by considerable ulceration. The late Professor Dorsey, of this city, observed a case of gangrene and death from a wound of this kind in a lady, previously in good health. So serious an effect as this is probably always dependent upon some idiosyncrasy, or upon the occurrence of erysipelas, consequent upon the bite. The stinging sensation and swelling which attend the application of the poison of the mosquito usually soon subside of their own accord, or under the use of some mild stimulant, as Cologne water, alcohol, vinegar, or laudanum. When the effect is more serious, tincture of iodine and warm water-dressing may be necessary.

The poison of the *scorpion* has many of the properties of that of the bee and wasp, although it is much more active. It is of a whitish color and oleaginous consistence, and is contained in a small reservoir near the end of the tail, whence it is ejected through two little pores on each side of the sting. In North America and Europe the wound inflicted by the insect is comparatively harmless, the only effect generally being a slight, transient inflammation; but in Africa and Asia it is often followed by great suffering and even loss of life, death sometimes occurring in a few hours. In those countries the scorpion frequently attains an enormous size, having a huge body, and a length of six to ten inches. Several species of this insect, of large size, are found in Cuba, Texas, Mexico, and South America, but I am not aware that their sting is particularly venomous. The great Eastern remedy in this variety of wound is olive oil, and an idea prevails that its virtues are greatly enhanced by infusing in it the bodies of some of these animals previous to its application. Spirit of hartshorn would doubtless be a more valuable addition. Such a wound should always be immediately well washed with salt water, then scarified, next thoroughly rubbed with volatile liniment, and then covered with an emollient poultice. If constitutional symptoms arise, they must be combated with anodynes, brandy, and ammonia, the treatment being very similar to that adopted for the sting of the bee and wasp.

Bad effects sometimes supervene upon the bite of the *spider;* and the fabulous stories about the poisonous qualities of the tarantula are known to every reader of history. The most prominent of these effects is a sense of itching at the wound soon followed by violent pain, difficulty of breathing, frequency and weakness of the pulse, nausea, copious perspiration, and general prostration. The symptoms of the bite of the tarantula are very similar to those produced by the sting of the common scorpion. The chief remedies in both cases are alcoholic and ammoniated stimulants, with opium, to relieve pain and to assist in sustaining the heart's action.

The bite of the *centiped*, which, in some countries, as the East and West Indies, Africa, South America, and the Southern regions of the United States, often attains a length of five to seven inches, is occasionally followed by severe symptoms, and even death, as in a case related by Dr. Lincecum, in the American Journal of the Medical Sciences for October, 1866. The poison bag, lodged near the base of the jaw of the insect, is of an oblong shape, and has a long, narrow, excretory canal, with a small opening at the extremity of the hooklet. The bite is exceedingly painful, and is frequently followed by considerable swelling and discoloration, along with more or less fever and even delirium. In the case observed by Dr. Lincecum, the patient survived the bite only about six hours. The prominent symptoms were, great general uneasiness, coming on immediately after the injury, excessive nausea, and frequent vomiting, which gradually increased in violence until the child, in a convulsive struggle, ceased to breathe. The whole surface was dappled with livid spots, from the size of a five-cent piece up to that of a dollar, and there was an elastic puffiness, giving the whole person a singularly tumid appearance. The treatment of such a wound must obviously be conducted upon the same general principles as the sting of the bee and other insects, the most reliable antidotes being ammonia and alcohol, along with anodynes. The immediate application of a cupping glass materially lessens the danger by preventing the ingress of the venom.

2. WOUNDS INFLICTED BY VENOMOUS SERPENTS.

The number of poisonous serpents in different parts of the world is very considerable; but in this country there are, so far as is at present known, only three genera that are at all dangerous on account of their bite. These are the crotalus, trigonocephalus, and elaps. Of the crotalus, or rattlesnake, so called from the peculiar appendage to its tail, Professor Holbrook, in his Herpetology of North America, has described not less than six species, of which the banded, striped, and miliary are the most common; all are

venomous, and, consequently, capable of inflicting deadly wounds. These reptiles formerly abounded in almost every section of the United States, especially in the swampy and mountainous regions, but are now very seldom met with in our denser settlements.

All the different species of rattlesnakes are provided with two small sacs, each of which contains a minute quantity of poison, and communicates, by means of a short excretory duct, with the canal in the fang on each side of the upper jaw. It is inclosed in a bony framework, situated external to the proper jaw, and is under the control of appropriate muscles, the action of which aids materially in expelling its contents. The fangs, situated just at the verge of the mouth, are very long, sharp, and crooked, like the claws of a cat, and are naturally retracted and concealed in a fold of integument; but, when the animal is irritated, are capable of being instantly raised, and darted forward with great force into the skin, followed by an emission of poison. The snake, then, does not bite, but strikes, making a punctured wound.

The annexed illustrations represent the head of the rattlesnake, and one of the poison fangs, with the canal along which the venom flows when the animal is in the act of inflicting its wound.
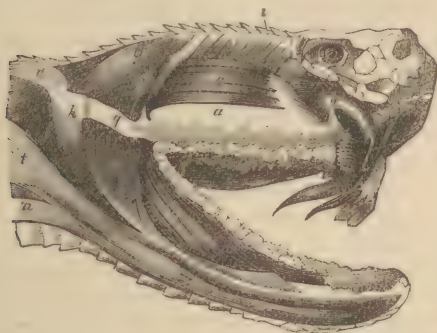
Fig. 117.   Fig. 118.

Fig. 117. Head of the Rattlesnake. *a, a.* Poison Gland, and its Excretory Duct; the latter cut open at its extremity. *e.* Anterior Temporal Muscle. *f.* Posterior Temporal Muscle. *g.* Digastric. *h.* External Pterygoid. *i.* Middle Temporal. *q.* Articulo-Maxillary Ligament, which joins the Aponeurotic Capsule of the Poison Gland. *r.* The Cervical Angular Muscle. *t.* Vertebro-Mandibular Muscle. *u.* Costo-Mandibular Muscle.

Fig. 118. Poison Fang, magnified. *p, p.* The Pulp Cavity of the Tooth. *v, v.* The Canal along which the Venom flows, truly on the outside of the Tooth.

The poison of the rattlesnake is a thin, semitransparent, albuminous fluid, of a yellowish color, with, occasionally, a tinge of green. According to Dr. S. Weir Mitchell, of this city, who has carefully studied its qualities, it is of a glutinous consistence, devoid of smell and taste, distinctly acid, of the specific gravity of 1044, and coagulable at a temperature of 143° to 160°. Its toxic activity is not materially, if at all, impaired by boiling and freezing, and alcohol, acids, alkalies, iodine, and chlorides do not destroy its virulence. When dried, it retains its noxious properties for an indefinite period. In an experiment performed by Dr. A. G. Taylor, two grains of the powder, which had been kept for twelve years, mixed with water, and injected under the skin of a rabbit, caused death in forty-five minutes. It contains, besides coloring matter, and an undetermined substance, both soluble in alcohol, a trace of fatty matter, chlorides and phosphates, and two albuminoid principles, one coagulable at 212°, the other, termed crotoline, not coagulable at this temperature, neutral in its action, freely soluble in water, and of a nitrogenous nature.

The quantity of venom contained in the poison-bag does not generally exceed a few drops; but it accumulates when the animal is inactive, and Dr. Mitchell had a snake which, on one occasion, ejected fifteen drops, its fang not having been used for several weeks. It is peculiarly acrid and deadly in hot weather and during the procreating season. In winter and early spring the reptile is in a torpid condition, and the poison is then diminished in quantity, and unusually thick, although not less virulent.

The effects of the wound of the rattlesnake vary with many circumstances, as the situation of the part, the acrid character of the poison, and the age of the patient. Experience has shown, as in the case of the bite of rabid animals, that most of those hurt in this way

escape either entirely or suffer only in a very slight degree; the poison either failing to reach the tissues, or being too inert to make any decided impression upon the system. It is also known that adults are less liable to suffer than children, simply because they possess, as may be supposed, greater vigor of constitution, and, consequently, greater power of withstanding the influence of the venom. The deleterious effects of the poison seem to be much weakened, if not actually exhausted, by a rapid succession of bites. The experiments of Captain Hall, of Carolina, and of Professor B. S. Barton, of this city, place this matter in a very clear light. Of three dogs bitten in succession by a rattle-snake four feet long, the former gentleman found that the first died in less than a quarter of a minute, the second in two hours, and the third in three hours. The subjects of Barton's experiments were chickens, and the results were almost identical with those of Hall. Of three fowls, bitten on three consecutive days, the first perished in a few hours, the second lived for some time, and the third finally recovered, although not without considerable suffering. Instances are occasionally met with in the human subject of almost instant destruction from the bite of the rattlesnake, as in a remarkable case which occurred at Baltimore, in which a man, bitten at two places on the cheek, died in twenty-eight minutes. In a case related by Dr. Shapleigh, of this city, death occurred in three-quarters of an hour, the man being struck on the forefinger, directly over the second joint. At other times the case proceeds more slowly, the patient surviving several hours, or, perhaps, even several weeks. Dr. Wainwright, of New York, lost his life in less than six hours from the time he was wounded. The reptile, an uncommonly large one, had lain in a torpid state for some time, when, unexpectedly becoming warmed, he struck his victim furiously on the last phalanx of the middle finger of the left hand. Although the wound was immediately sucked, and soon afterwards excised and cauterized, a ligature being also tied firmly round the wrist, the hand soon became enormously swollen, the tumefaction speedily extending up the limb nearly as far as the axilla, and the surface, in the greater part of its extent, exhibiting a mottled bluish and greenish-yellow hue. The pulse was very small and frequent, unconsciousness rapidly supervened, and the patient expired in a completely comatose state, preceded by nausea and excessive restlessness. Finally, in another series of cases, the patient, after having been near death's door for several weeks, eventually perishes or recovers. When death occurs almost instantaneously, the probability is that the poison is injected directly into the blood, the fang having penetrated some tolerably large vessel. Under such circumstances, the fluid is found to be thin, black, and uncoagulable on exposure to the atmosphere.

When this poison is freely instilled into a wound, the symptoms will always be proportionately severe. The moment the inoculation has taken place, excessive pain is experienced in the part, rapidly followed by swelling, which soon diffuses itself extensively over the surrounding surface, and is attended with a livid, mottled appearance, dependent upon extravasation of blood into the subcutaneous connective tissue. If the wound, for instance, occupies a finger, the tumefaction speedily extends up the limb, as far as the shoulder, and, perhaps, over a large portion of the corresponding side of the trunk, a feeling of numbness, weight, and coldness attending the other symptoms.

Within a few minutes after the first manifestation of the local affection, marked evidence appears of the absorption of the poison into the system. The patient looks excessively pale, sees objects indistinctly, is sick at the stomach, perhaps ejecting its contents, and has frequent swooning fits, with clammy sweats, and coldness of the body. By and by, as the system becomes more fully impressed with the deleterious effects, insatiable thirst arises; a sense of constriction is experienced in the chest; the breathing is oppressed; the pulse is feeble and vacillating; great anxiety and restlessness exist; the tendons twitch; the mind wanders, or is furiously delirious; and death soon closes the scene. In the worst cases of the affection, a universal yellowness of the skin is observed, and the parts are not only frightfully swollen, but, if the patient survive some hours, large vesicles appear upon the surface, containing bloody serum, and indicating the approach of mortification. When death does not take place for a considerable number of days, large abscesses form in the connective tissue under the skin and among the muscles, and the system gradually sinks under the resulting irritation.

The appearances presented in the bodies of those who die from the effects of this poison are pretty uniform. In the birds, rabbits, guinea-pigs, and dogs experimented upon by Dr. Mitchell, extravasation of blood and softening of the tissues in the neighborhood of the bite were almost invariably observed; the brain and spinal cord were more or less injected; the heart was distended and flabby; the lungs were sometimes engorged; and the intestines were occasionally ecchymosed. In several instances the kidneys were

acutely congested and filled with blood. The ureters and bladder contained sanguineous urine. The blood in the heart and vessels was dissolved, and of a dark color.

The genus *trigonocephalus* includes several species, of which the water moccasin, or cotton-mouth, and the copperhead, are the most important. They have no rattles, but the upper jaw is armed with poisonous fangs, and their bite is very deadly. The cotton-mouth snake is met with extensively in the Southern States, its northern limit being the Pedee River in North Carolina. Professor Holbrook states that it is the terror of the negroes about the rice plantations, being more dreaded by them than the rattlesnake, which attacks only when irritated, whereas the water moccasin makes war on everything that comes within its reach.

Of the genus *elaps*, the only species known in this country is the elaps fulvius, whose body, twenty inches in length, is of a beautiful red color, surrounded with black rings, margined with yellow. Its upper jaw is armed on each side with a permanently erect poisonous fang. It is found chiefly in the Southern States, in sweet potato fields, and is so gentle in its habits as to be regarded as almost harmless.

The most noxious serpent in the East Indies is the *cobra di capello*, the spectacled or hooded snake, of which there are a number of varieties, all distinguished for their venomous properties. The effects of its bite are very similar to those of the rattlesnake, only that they are generally somewhat more tardy, and accompanied by less swelling. The poison is of a semitransparent, yellowish appearance, not unlike olive oil. It has been known to kill a large dog in less than twenty minutes; and in the case of the keeper at the Zoological Gardens in London, who was bitten by a cobra on the root of the nose, death occurred in ninety-five minutes. The internal viscera were found, on dissection, to be intensely congested, and the blood, which was dark, alkaline, and fluid, emitted a peculiarly acid and sickening smell. In an instance observed by Sir George Ballingall, a girl, a native of India, expired in a quarter of an hour after she had been bitten by a serpent of this kind, notwithstanding the excision of the injured part, and the exhibition of large quantities of ammonia. Experiments performed by Sir Joseph Fayer, formerly of Calcutta, show that the poison of the cobra may exert its virulent effects by absorption through contact with the mucous and serous membranes. The poison of the phursa—the echis carinati of naturalists and the most common of all the East India serpents—is comparatively slow in its action, and only about 20 per cent. of the cases prove fatal.

In Europe, the *viper* is the most venomous serpent known. It is rare in England, but sufficiently common in France, Spain, and Italy, as well as in several of the more northern States of the Old World. The poison, which has a yellowish, oily appearance, may be swallowed almost with impunity, provided there is no abrasion upon the mouth. It is most active in hot weather, killing small birds and animals almost instantly. Applied to the human subject, it causes acute pain and diffused swelling, followed by a puffy, œdematous state of the subcutaneous connective tissue, and a livid and vesicated condition of the skin. The general symptoms, which seldom manifest themselves under three-quarters of an hour to an hour, bear so close a resemblance to those produced by the wound of the rattlesnake as to render it unnecessary to describe them.

A great deal has been written concerning the *treatment* of wounds inflicted by venomous serpents, and yet there is not a solitary reliable remedy. The fact that so many articles have been recommended as specifics clearly shows that these lesions are often so slight as not to require any treatment at all, the unpleasant effects generally passing off spontaneously in a few hours, either because the poison has not been introduced in sufficient quantity, or because it has been too inoxious to produce any serious harm. The first thing to be done, so far as the part is concerned, is to constrict the limb as tightly as possible, a short distance above the wound, which is then to be instantly excised and cupped, the glass being retained as long as the blood is disposed to flow, when the surface should be well washed with dilute tincture of iodine, the same remedy being thoroughly applied to the skin over the whole extent of the swelling. Subsequently, warm water-dressing, medicated with laudanum and acetate of lead, will form the most suitable application. Thorough constriction of the limb with Esmarch's bandage, or, in the absence of this, with a tightly drawn roller, might be of service in retarding the entrance of the poison into the system, and affording time for the operation of medicines administered internally.

The practice of sucking the wound is of great antiquity, and there have been men, from time to time, in different parts of the world, who have made it their special occupation. The Psylli, of Africa, and the Marsi, of Italy, acquired great celebrity for their skill in this business, and the custom still prevails among many of the Indian tribes of this

continent. The operation, however, cannot be performed with safety if there is any abrasion upon the lips or in the mouth, and should, therefore, always give way to the cupping glass.

Pain must be relieved, and the strength supported by morphia and alcohol, the latter being given, in any of its more common forms, to the utmost possible extent compatible with the patient's power of endurance. Whiskey is the great remedy, although it is not a specific, among the mountaineers of this country for this class of wounds, and there can be no question that it is entitled to great consideration. The treatment should be rapidly pushed to gentle inebriation, as men bitten when dead drunk have been known to die, although such an occurrence is seldom to be looked for when there is such marked depression of the general system as so often attends this lesion. Ammonia may occasionally be advantageously combined with the alcohol on account of its diffusible stimulating properties. When there is excessive prostration, along with great gastric irritability, enemata of brandy and laudanum should be employed. Olive oil has been highly recommended as an antidote against snake-bite; but experience has shown that it possesses no such virtues. In the East Indies, the Tanjore pill formerly enjoyed great celebrity in the treatment of wounds inoculated with the poison of the cobra di capello and other noxious serpents, its efficacy being supposed to depend upon the arsenic which enters into its composition. Fowler's solution has also been much lauded for its supposed neutralizing qualities, especially of the poison of the fer-de-lance, a venomous serpent in the Island of St. Lucia: it is administered every three hours in doses of two drachms along with a small quantity of laudanum, until active vomiting and purging are induced. But none of these remedies are reliable, and my opinion is that no time should be wasted upon their exhibition.

In the first edition of this work attention was directed to the use of Bibron's antidote, as it has been called—a mixture of bromine, iodide of potassium, and bichloride of mercury—as a means of neutralizing the effects of the poison of the rattlesnake; but it has been ascertained by Dr. Mitchell that it possesses no such properties; nor are arsenic and ammonia, or, indeed, any other articles of the materia medica, so far as we know, endowed with such virtues. In regard to topical remedies, he found, experimentally, that iodine, injected subcutaneously, as originally suggested by Brainard, of Chicago, exerted a great influence over the local effects of the venom, but none in preserving life or defending the system at large. Some simple astringents also possess this power, and are equally as useful as iodine. Carbolic acid, injected into the envenomed tissues, sometimes delays the fatal result, and usually lessens the local hemorrhage. Among the internal stimulants, he assigns, in common with all American practitioners, the highest rank to alcohol, looking upon it, not as a chemical antidote, or neutralizer of the venom, but as a great supporter of the vital forces. When the patient is too weak or too sick to swallow, it may be administered in the form of an enema; and in that event, the inhalation of hot alcohol, or even of ether, will be of service as a means of reëxciting the flagging energies of the system. In a severe case of rattlesnake poisoning, recently under the care of Dr. Moorman and Dr. Fuqua, large quantities of iodide of potassium conjoined with alcoholic stimulation seem to have been attended with marked benefit, the patient making a good recovery, although the limb was enormously swollen, and the system greatly exhausted. When the immediate effects of the poison have passed off, quinine and a nutritious diet will be necessary, along with spirituous stimulants, to aid restoration. Dr. Mitchell has ascertained, by direct experiment, that carbolic acid and the sulphites of sodium and lime possess no antidotal power.

Finally, it may be observed, in regard to the so-called antidotes for snake-bite, that the remedies which have, from time to time, been invested with this virtue, doubtless owed their temporary reputation to the fact that the cases in which they were used were cases of a comparatively slight character, which would probably have recovered as well, or nearly as well, without as with their use. The history of surgery certainly warrants this conclusion.

3. WOUNDS INFLICTED BY RABID ANIMALS.

There is a peculiar disease in man and animals known by the name of hydrophobia, its characteristic symptoms, at least in the human subject, being a dread of water, as the term by which it is generally designated literally signifies. It is due to the influence of a particular poison, generated by certain animals, and capable of propagating the disease by inoculation. Of the nature of this poison all that is known is that it is contained in the saliva, and that, after having remained latent for some time in the wounded part, it

is absorbed and carried into the system, where it produces the peculiar effects by which the malady is distinguished.

That the virus of hydrophobia resides in the saliva, and not in the secretion of the mucous follicles of the mouth and fauces, has been fully established by experiments upon the inferior animals. Thus, Zinc inoculated a dog, cat, hare, and cock, with the saliva of a rabid dog, and readily induced the disease. Similar results followed the investigations of Depuy, Youatt, and other veterinary surgeons. The former of these writers rubbed a sponge wet with the saliva of a mad dog upon the sore of a sheep, which subsequently perished from hydrophobia; and the latter communicated the affection from one brute to another by means simply of a silk thread, impregnated with this fluid and used as a seton. If further proof of this fact were needed, it could be found in the experiments of Raymond, who repeatedly induced the disease in healthy rabbits by inoculating them with the salivary glands of rabid ones. Magendie and Breschet developed hydrophobia in dogs by inserting frothy fluid taken from the mouths of human beings affected with rabies. Dr. Gaultier, of Lyons, finds that the saliva of a rabid dog is perfectly harmless if injected into a vein, and that its contact with the nerves is indispensably necessary to produce the disease.

It is supposed by many pathologists, as Bouley, Fleming, Lindsay, and Brueckenmueller, that certain animals, as the dog, wolf, fox, jackall, and badger, if not also the cat, tiger, and lion, have the faculty of generating the virus of hydrophobia spontaneously; while others, as Magendie, Dupuytren, Breschet, Bollinger, and Virchow, positively assert that rabies can only originate from inoculation with the peculiar virus of this disease. The latter doctrine is certainly the more plausible of the two, as it is much more in accordance with our knowledge of the habits of other poisons. I cannot, indeed, see how the affection could be induced in any other manner. It is extremely probable that all the higher classes of animals are capable of contracting hydrophobia by inoculation. Breschet repeatedly induced it in dogs by inserting the saliva of rabid horses and asses; and cases have been reported of human beings having suffered from the bite of rabid horses and pigs. It is uncertain whether hydrophobia can be communicated from one person to another. In the case of Wheeler, a dresser at Guy's Hospital, London, who was bitten by a rabid patient, no ill effects followed, and I know of no well-authenticated instance of the disease having been produced in this wise. Rabbits and similar animals, as well as fowls, soon die from inoculation with this poison, without exhibiting any of the ordinary symptoms of hydrophobia.

The inoculation in hydrophobia is usually effected by the teeth, which, however, need not necessarily penetrate the true skin, as the disease may readily be communicated by the slightest scratch or abrasion. An instance has been reported in which death was produced by the licking of a wart upon the face, by a poodle supposed to be laboring under rabies. It has been conjectured that the disease may be communicated merely by the contact of the saliva of a hydrophobic animal with sound skin and mucous membrane. It is also believed to be possible that a mother may transmit the affection to her infant through her own milk. Cases now and then occur which lead to the suspicion that the disease may be induced by dogs and other animals not actually mad, but simply enraged, or in which the disease is simply in its incubative state. Finally, experiments have been performed which prove that the morbid saliva may be administered internally with entire impunity.

It is notorious that many of the persons bitten by rabid animals do not contract hydrophobia, the saliva containing the specific virus being no doubt wiped off as the teeth penetrate the clothes. Hunter and Hamilton supposed that out of twenty or thirty persons bitten only one would take the disease, an estimate altogether too low. The wounds inflicted by rabid wolves are much more dangerous than those of rabid dogs, the differences being due to the fact either that the virus of the former animals is more virulent than that of the latter, or else that wolves generally attack the exposed parts of the body, as the face, neck, and hands, whereas dogs more generally infix their teeth into those that are covered. Of 254 persons bitten by rabid wolves, 164, according to Renault, died of hydrophobia. For a similar reason the bite of a cat is always peculiarly dangerous.

The period of latency of this disease varies from a few weeks to several months. In 89 cases, analyzed by Dr. Blatchford and Dr. Spoor, of Troy, the average period was about seventy days, the minimum in 23 cases was thirty days and under, and the maximum in 6 cases was upwards of two hundred days. According to Bollinger sixty per cent. of all cases occur between eighteen and sixty-four days. In the only three cases of hydrophobia that I have ever seen, the disease appeared, in two, at the end of four weeks, and in

the other nine months from the date of the inoculation. In an instance under the care of Dr. Demme, of this city, the patient, a man, aged twenty-six, had been bitten eighteen months previously. Dr. J. W. Lodge has reported to me the particulars of a case of hydrophobia in a child three years old, in which the period of latency was precisely seven weeks. According to John Hunter, the extremes range from thirty days to eighteen months. Wenderburg has related an example in which the poison remained quiescent for four years; Breva, one of five years; and Bardsley, one of twelve years; each, apparently, well authenticated, and yet wholly unreliable. An undoubted case of hydrophobia, in which the poison remained in a latent condition for nearly three years and a half, occurred in this city last winter, in a young man, twenty-two years of age. Death took place in less than three days from the commencement of the attack. The time of incubation is generally considerably shorter in animals than in man, and in very young persons than in adults.

Although a considerable period always elapses between the inoculation and the appearance of hydrophobic symptoms, it is extremely probable that the virus is speedily absorbed into the system, although some time is necessary to develop its zymotic properties. What countenances this view is that nearly all the other known poisons, when brought in contact with the living tissues, are promptly absorbed, so as to make, sooner or later, their peculiar impression upon the constitution. The poison of syphilis is absorbed very speedily, and the probability is that the same is true with respect to the virus of smallpox, measles, scarlatina, and other zymotic affection. A certain period, however, is necessary, in every case, to enable the poison to explode upon the general system, or, in other words, to increase its virulence and extend its influence. With regard to the virus of rabies, it is a well-known fact that the disease is often developed within the usual period, after the most prompt and thorough excision of the bitten parts.

When the virus lies in a dormant state for an unusually long period, it is no doubt locked up, as it were, in the cicatrical tissues of the wound in such a manner as to be unable to extricate itself until, by some organic changes, of the precise nature of which we are ignorant, they are so softened and disintegrated as to bring it under the control of the absorbent vessels, through the agency of which it finally gains admission into the system.

Many persons are bitten by rabid animals and yet never contract the disease, the virus having either been exhausted before the rencontre takes place, or, what is more probable, having been wiped off by the clothes in the act of inflicting the wound. In this way more than half of those bitten occasionally escape with impunity; on the other hand, it sometimes happens that nearly every one is effectually inoculated. It is not impossible that idiosyncrasy may exert an important influence in the production of the disease. It is well known that this is true of other zymotic poisons, and it is, therefore, reasonable to suppose that it may also hold good of this. Of fifty dogs inoculated by Dr. Herwitch, of Berlin, with saliva taken from a rabid animal of the same species, not one in five was affected.

Hydrophobia is not peculiar to any age. It has been observed in infants at the breast, in children, and at every period of adult life. It occurs in all countries, in all climates, and at all seasons of the year. France, Italy, Austria, Russia, and Germany, however, have furnished a greater number of cases than any other parts of the world. It is also frequently met with in England; and, as a general rule, it is more common in northern than in southern regions. Throughout the West Indies it is comparatively rare, although the number of dogs there is unusually great as compared with the number of inhabitants. Hydrophobia is more common in Canada and New England than in the Southern States of the Union. Of 2520 cases observed on the continent of Europe, in Great Britain, and in the United States, and referred to by Dr. Charles P. Russell, in Johnson's Universal Cyclopædia, 1704 occurred in the spring, 621 in the summer, 608 in the autumn, and 587 in the winter, thus showing that the influence of season is comparatively slight.

The *symptoms* of rabies necessarily divide themselves into local and constitutional; or those furnished by the wounded part, and those afforded by the system, after the absorption of the specific virus.

The wound inflicted by a rabid animal generally heals as kindly as any similar wound made by a sound animal; the scar, perhaps, remaining a little red and tender, as it usually does after an ordinary bite, but exhibiting no other peculiarity, and the system being perfectly free from disease. By and by, however, when the period of incubation is about to draw to a close, the part begins to itch, burn, or smart, and soon becomes sore and irritable, hot, numb, or rigid, pain darting through it in different directions, and sometimes extending to a considerable distance beyond the site of injury, as from the

hand up to the shoulder, or from the foot to the knee or groin. Sometimes the wound reopens, the cicatrice gives way, or red lines are traceable in the direction of the lymphatics. Almost simultaneously with the local affection, evidence of general indisposition appears. The patient feels unwell; his head aches; his sleep is disturbed by unpleasant dreams; he feels melancholy and depressed; and he has occasional attacks of chilliness, with a highly impressible state of the system. The poison is now fairly at work, and in a few hours—generally from twelve to twenty-four—explodes with frightful violence. The period of latency is passed; the disease has reached its second stage; the dread of water and the difficulty of deglutition have declared themselves; in a word, hydrophobia is fully established. The patient, on attempting to drink, is suddenly seized with spasm in the throat, and finds that he is unable to swallow a particle of fluid; he tries and tries, but every effort is only succeeded by a renewal of suffering, and presently he dashes away the cup as if it were charged with some deadly poison, unwilling again to bring it to his lips. Tortured with thirst and a sense of dryness of the mouth, he will endure his discomfort rather than subject himself to the dreaded spasm. Should he succeed in forcing down a little water, he will be instantly seized with suffocative cough, convulsive tremors, and lividity of the face, compelling him to jump up in bed, and to pant for breath. The painful sensations are usually referred to the throat, and are often accompanied by a feeling of constriction in the chest, difficulty of respiration, a disposition to sigh, and a frequent desire to clear the mouth and fauces, which soon become clogged with an inordinate secretion of thick, viscid saliva and mucus, which greatly aggravate the patient's suffering. At this stage of the disease, and, generally, indeed, before it has reached this point, there is superadded to the previous distress a remarkable susceptibility to atmospheric impressions, the slightest contact of cold air being a source of profound torture, producing a sense of suffocation and even violent convulsions. The agony thus occasioned is sometimes much greater than that caused by the attempt to swallow fluids. The least opening of a door, the slightest motion of a fan, or even the smallest whiff of air directed from the attendant's mouth upon the body, instantly brings on a paroxysm of this kind. Light and noise, too, are always offensive; and hence the patient usually insists upon his room being kept dark, quiet, and closed. The mind, at this stage, is peevish and fretful, and nothing that can be done pleases the sufferer, who, in consequence, often quarrels with his best friends. At times his imagination is completely perverted; he fancies that he hears noises and sees objects that have no real existence; he gets out of bed, walks about the room, screams, or gesticulates, very much like one affected with delirium tremens.

In the last stage, which is characterized by an aggravation of all the previous symptoms, the countenance has a haggard and distressed appearance, horror and anxiety being depicted on every feature. The pupils are dilated, and the eyes have a wild, glaring expression; the tongue is dry and parched; the voice is hoarse and shrill, almost like that of a dog; the respiration is short and panting; more or less delirium is present, often amounting to complete mania; the strength is much impaired; and the pulse, small and feeble, beats from one hundred and thirty to one hundred and sixty in the minute. Thus the disease progresses, paroxysm after paroxysm recurring until the frame is worn out by exhaustion, death usually taking place suddenly in a fit of suffocation. Occasionally a slight calm is experienced a few hours before the fatal event; the spasms almost completely subside, the power of swallowing returns, the mind becomes clear, and the patient, perhaps, sinks into a tranquil sleep. The duration of the attack varies, on an average, from thirty-six hours to three days.

In a case of hydrophobia which I attended in 1842, the patient, a young man, twenty-one years of age, was attacked precisely four weeks after having been bitten in the left hand by a rabid dog. When I first saw him the disease was already in its second stage, well-marked symptoms having appeared the previous day. The difficulty of swallowing and the morbid sensibility of the skin were present in a high degree. Every effort at drinking, nay, the very mention of fluid of any kind, and the attempt to raise the glass to the lips, caused violent convulsions; the countenance was flushed and tumid; the eye red and suffused; the mouth parched; the throat clogged with viscid mucus; the pulse frequent and rather strong; the respiration hurried; the thirst and restlessness intense; the mind exceedingly peevish and irritable; and the sensibility of the skin so exalted that the slightest approach to a current of air, inappreciable by any one else, produced the most horrible torture. The inability to bear light and noise was also very great. The hand felt numb and painful, although the wound had not reopened. These symptoms gradually progressed, increasing steadily in severity, until towards the end of the third

day from the attack, when the young man expired in a state of complete exhaustion. The pulse, during the latter stage of the malady, was exceedingly irregular, and upwards of one hundred and fifty in the minute; the breathing was short and panting; and the mind was excessively agitated and distressed, but clear and intelligent, except when a convulsion was about to occur. The voice was not materially affected.

It is impossible to mistake hydrophobia for any other disease. The dread of water, the difficulty of deglutition, and the suffering occasioned by the contact of cold air, are always sufficiently diagnostic of the affection, even when no history of it can be obtained.

The *dissection* of persons dead of this disease has thrown no light upon its seat or its pathology. In the case of a young man of twenty-four, who died in 1840, nine months after he had been bitten on the hand, and whose body I assisted in examining, no lesion whatever could be detected by the closest scrutiny. The mouth, fauces, pharynx, and œsophagus, the larynx, trachea, and bronchial tubes, where disease might naturally be supposed to exist, under such circumstances, were perfectly free from morbid appearances. The brain and spinal cord, lungs, stomach, bowels, and other viscera, were equally sound. Occasionally, especially in protracted instances, the membranes of the brain have been found congested, and the ventricles partially filled with serum. The stomach, œsophagus, and pharynx have also been found inflamed; and several cases are mentioned where pus was discovered in some of the larger joints. Very little reliance, however, it seems to me, should be placed upon such reports, especially when we consider the loose manner in which most of them are drawn up, and the fact that comparatively few men are competent to make accurate dissections. Microscopic inspection in the hands of Meynert, Benedict, Hammond, Schultze, Wassilieff, Gower, and others, has thrown no reliable light upon the subject.

The *prognosis* of hydrophobia is always bad, the disease invariably ending fatally. There is no case of recovery, of a reliable character, upon record. I know that a number of instances have been published in which the patient is said to have got well, but there is not a single one, so far as my information extends, that can withstand the test of scientific scrutiny.

The period at which death occurs is generally very short. The average in 72 cases, analyzed by Blatchford and Spoor, was three days. Of 120 cases, collected by Dr. J. L. Smith, of New York, 65 perished in from one to two days. In some instances the disease proves fatal during the first twenty-four hours, while in others this event does not happen until the tenth day, although when postponed so late it must necessarily create very great doubt as to its true nature.

In the *treatment* of this variety of poisoned wounds, reliance must be placed solely upon preventive measures; for, as just stated, when the disease is once developed, there is no possible chance of doing anything more than mitigating the suffering, and even that only in a slight degree. If, as I have supposed, it be true that the poison is speedily absorbed after being brought into contact with the living tissues, the importance of promptly dislodging it cannot be too forcibly impressed upon the attention of the practitioner. As soon, therefore, as such a case is presented to his notice, the injured part should be thoroughly excised, along with a portion of the sound tissues. The flow of blood is then to be encouraged with a cupping glass, retained for some time, when the raw surface is well cleansed, and immediately cauterized with nitrate of silver. If the teeth of the rabid animal have penetrated between two bones, as, for example, when the bite has been inflicted upon the hand, excision must be performed with increased care, otherwise a portion of the virus will be liable to be left behind. In such a case it might become a nice question to determine whether the operation should not be made to include a portion of the bones also; for almost any local sacrifice is justifiable to secure immunity from so horrible a disease. It would seem from the observations of Mr. Youatt and Mr. Blane, two eminent veterinary surgeons, that there is no remedy which so certainly neutralizes this poison as nitrate of silver. The former of these writers, whose opinion is entitled to the greatest respect on account of his large experience in the treatment of canine madness, states that he employed this article in upwards of 400 persons, as well as repeatedly upon himself, with complete success, and such was his confidence in its virtues that he regarded it in the light of a specific. His plan was to cleanse the parts well with soap and water, and then to cauterize them most thoroughly, previously enlarging the wound, if necessary. If I were myself so unfortunate as to receive such an injury, I should certainly feel more confidence in my escape, if the wounded structures had been excised and cupped prior to the application of the caustic.

Excision should also be practised even when the injured part has been neglected, or imperfectly removed in the first instance, it being well known that the individual may escape the constitutional effects of the disease after the wound has begun to fester, or after it has partially reopened. But even if there were no hope of preventing the development of the disease by this procedure, it should, nevertheless, be adopted if for no other reason than the soothing effect it would exert upon the mind of the poor sufferer. Everything tending to allay his fears and contribute to his comfort is justifiable under such trying circumstances. If the symptoms of hydrophobia, however, have already been developed, neither such an operation, nor even the amputation of the limb above the site of injury, can be of any service.

When the poison has reached the system, and has evinced its explosive effects, no treatment, however judiciously and perseveringly conducted, is of any avail as a curative agent. The experience of two thousand five hundred years fully attests the truth of this statement. The whole materia medica has been exhausted in search of a remedy for this disease, and there is hardly any article, vegetable or mineral, that has not been used, either singly or combinedly, and yet no instance has ever occurred in which any permanent benefit ensued.

To relieve the frightful suffering from the disease, chloroform and ether, either alone, or variously combined; morphia, in large quantities in the form of hypodermic injections, frequently repeated; the application of steam conveyed to the patient's body as he lies in bed; and the exclusion of cold air, noise, and light from the apartment, constitute the most reliable means. General bleeding, the hot bath, and tartar emetic, so much vaunted by some, will only expedite the fatal issue, without affording any decided mitigation of the suffering. Opium is of no use, even if given in enormous quantity, as the stomach cannot dissolve it. An ice bag stretched along the spine may do good by allaying nervous excitability. The food should be given in the most concentrated form, or what is preferable, administered by the rectum. Dr. Physick, with a view of relieving the dyspnœa, and preventing suffocation, advised laryngotomy, but I am not aware that it has ever been practised, or, if practised, that it has ever done any good. It certainly could not cure the disease, and it admits of doubt whether it would even moderate the spasm. More benefit will, I am sure, accrue from the hypodermic use of morphia, and from the exhibition of the bromides and of chloral, in allaying the terrible distress, mental and corporeal, than from all other means combined, unless an exception be made in favor of nitrite of amyl, to which attention was called in connection with this affection, in 1877, by Dr. William S. Foster, of this city. Administered in doses of fifteen to twenty-five drops in the form of inhalation, it promptly calms the system, and enables the poor sufferer to swallow fluids with the greatest facility, a property which, so far as is now known, no other remedy possesses in such condition of the system.

Hydrophobia in the Dog.—In concluding the subject of hydrophobia, a few remarks may be made respecting the character of this disease as it occurs in the dog, as it is important for the practitioner to be able to judge of the probability of his having been mad in the event of his having bitten a human being.

How the disease originates in the dog is not ascertained. It has been supposed that unsatisfied salacity, the use of filthy and unwholesome food, too close confinement, and extremes of heat and cold, constitute so many causes of the malady; but it is obvious that, although this may be true, our knowledge at present amounts to nothing but conjecture, which further and more carefully conducted observation alone can either verify or disprove. The average period of incubation is about forty days, the minimum being a fortnight, and the maximum three months and a half. The higher classes of dogs suffer less frequently from hydrophobia than the mongrel breeds, and it is also affirmed that bitches are less liable to the disease than males; a statement which requires further proof before it can be accepted as true.

The early symptoms of rabies in the dog are thus graphically described by Mr. Youatt: "In the greater number of cases," he remarks, "there are sullenness, fidgetiness, and continual shifting of posture. When I have had opportunity, I have generally found these circumstances in succession. For several successive hours perhaps he retreats to his basket or his bed. He shows no disposition to bite, and he answers the call upon him laggardly. He is curled up, and his face is buried between his paws and his breast. At length he begins to be fidgety. He searches out new resting-places; but he very soon changes them for others. He takes again to his own bed; but he is continually shifting his posture. He begins to gaze strangely about him as he lies on his bed. His counte-

nance is clouded and suspicious. He comes to one and another of the family, and he fixes on them a steadfast gaze, as if he would read their very thoughts. ' I feel strangely ill,' he seems to say : ' have you anything to do with it? or you? or you?' Has not a dog mind enough for this? If we have observed a rabid dog at the commencement of the disease, we have seen this to the very life." Delirium is an early and characteristic symptom ; the dog sees imaginary objects, and often springs at them with a furious dart ; he is restless and excessively irritable, gazing wildly around, and snapping at everything within his reach. The saliva is secreted profusely, and collecting at the corners of the mouth, the animal makes frequent attempts to detach it with his paws ; his appetite is strangely perverted, and he will sometimes greedily devour horsedung, or even his own excrements ; the voice is changed in its character, being generally hoarse, and more or less shrill ; the eyes are singularly bright ; and the thirst is intense and insatiable, the dog drinking frequently, and having no fear whatever of water, as is the case with the human subject.

The disease is now in full force, and tending rapidly to a fatal issue. The muscular powers being greatly exhausted, the animal finds it difficult to sustain himself upon his limbs ; he reels and staggers about like a man in a drunken fit ; his tail is depressed, and the tongue protruded ; the eyes have lost their brightness, and are of a dull, glassy appearance ; the respiration is hurried and panting ; finally, worn out by his suffering, the poor creature dies, either from convulsions, or from sheer exhaustion, the duration of the attack varying from three to five days. The power of communicating the infection exists, according to Youatt, in all the confirmed stages of the disease, and continues even for twenty-four hours after the death of the animal.

4. GLANDERS, FARCY, OR EQUINIA.

The horse, ass, and mule are capable of spontaneously generating a disease, which, although it affects the whole system, expends itself with peculiar force and virulence upon the mucous membrane of the nose, causing violent inflammation and a copious discharge of thick, fetid matter. It is accompanied by a pustular eruption of the skin ; and the name by which it is generally known is glanders, from the fact that it is always associated with disease of the maxillary and of the lymphatic glands of the ear and neck. There is a form of the affection which is characterized by the development of small tumors beneath the skin in different parts of the body, varying from the size of a pea up to that of a hazel-nut, of a spherical shape, very hard, almost immovable, and generally exquisitely painful to the touch. When very numerous, they give the surface a remarkably tuberculated appearance. To this disease the term farcy is commonly applied ; and an attempt has been made by several writers to establish for it a distinctive character. Others, on the contrary, assert that it is identical with glanders, differing from it only in its location, or in the character of the structures in which it appears. This view of the case derives confirmation from the fact that the two affections often coexist, which could hardly happen if they did not possess a strong natural affinity for each other.

It is not likely that this disease, as was once supposed, arises spontaneously ; on the contrary, there is every reason to believe that it is invariably the result of the action of a peculiar virus generated during the existence of glanders. Absorption is generally effected with wonderful rapidity. Renault, surgeon to the Veterinary School at Alfort, inserted the poison into horses, and, although the wounded part was excised and thoroughly cauterized within one hour afterwards, they all died from the disease. Whatever its true nature may be, it is certain that the strongest and most healthy animals speedily contract it when exposed to its influence, hard usage, inadequate feeding, and confinement in damp and ill-ventilated stables, especially if underground, powerfully predisposing to its occurrence. It was at one time thought questionable whether the disease could be propagated by atmospheric agency ; but multiplied observation long ago fully settled that point. It would seem, indeed, that the air of an infected stable, after all the wood work, pavement, and plastering have been completely replaced, and every possible precaution used in regard to cleanliness, is capable of reproducing the disease in all its former severity.

The fact that glanders may occur in the human subject was first enunciated by Mr. Muscroft, in the Edinburgh Medical and Surgical Journal, in 1821. The case was that of a man who had accidentally inoculated his hand in cutting up a horse that had died of this disease ; violent symptoms soon showed themselves, and he expired in great agony at the end of a week. Since that time a number of similar examples have been recorded by other observers, thus indisputably establishing the transmissibility of glanders from

animals to the human subject. As yet no facts had occurred proving that the affection might be communicated from one human being to another, or from man to beast. In 1840, however, a case of this kind was admitted into St. Bartholomew's Hospital, London, which conclusively settled the question. The patient, a knacker, had died of glanders, and the nurse who attended him took the disease and also perished from it.

These facts regarding the transmissibility of glanders from animal to man, from man to man, and finally from man to beast, are of great pathological interest, and serve to inculcate the great necessity of caution on the part of the professional attendants and nurses in their intercourse with persons laboring under this horrible disease; since the smallest particle of the specific virus coming in contact with an abraded surface, or even the mere inhalation of the infected air of the patient's apartment, may give rise to the malady.

In the equine tribes of animals, glanders may be propagated by inoculation with the pus and mucus of the pituitary membrane, the fluids being inserted under the skin with a lancet, or rubbed upon the greasy heel of the horse. It may also be produced by applying these secretions to the mucous lining of the nose; and a curious case has been reported of its having been caused by introducing balls of farcied matter into the stomach. The poison of glanders seems to enter the system very rapidly; sometimes, indeed, almost instantaneously. Bouley and others of the Veterinary School at Alfort inoculated horses with the pus of this disease; and, although the inoculated structures were cut out one minute after its insertion, glanders speedily followed. An experiment performed by Mr. Coleman, of London, shows that the blood of an infected animal transfused into the carotid artery of a sound one, will rapidly engender the malady in its most virulent form.

The period of *latency* of this disease is generally very short, rarely exceeding two or three days. It is probably a little longer in the human subject than in animals, but the difference, if any, is very slight. It has already been seen that the first case that ever occurred, so far as is ascertained, in the human subject, terminated fatally at the end of a week from the time of the inoculation. The first local evidence of the disease is generally some swelling and tenderness of the maxillary glands, and inflammation of the mucous membrane of the nose; sometimes the one, at other times the other, taking precedence.

The *symptoms* of glanders naturally divide themselves into constitutional and local. Shortly after the inoculation, the patient begins to feel unwell; his head, back and limbs ache; chilly sensations, alternating with flushes of heat, creep over his body; sleep and appetite are impaired; the strength sensibly diminishes; the joints are stiff and sore; the spirits are depressed; the stomach is irritable; and the bowels are costive. After the lapse of twenty-four to forty-eight hours, a severe and protracted rigor generally occurs, followed by violent fever, profuse perspiration, and a marked elevation of temperature, the thermometer often rising to $102°, 103°$, or even $104°$ Fahr.; an evidence that the stage of incubation is passed, and that the poison has gained full admission into the system. The symptoms now rapidly assume a typhoid character. The pulse becomes quick, frequent, and tremulous; the tongue is dry and brownish; sordes accumulate upon the gums and teeth; the voice is weak and often husky; the respiration is short, panting, and accompanied by a sense of constriction across the chest; the surface is bathed with fetid, clammy perspiration; the thirst and jactitation are excessive; the urine is scanty and high-colored; the alvine evacuations are slimy and extremely offensive; the mind wanders; and the pains are atrocious.

Coincident with these phenomena there are marks of serious disease of the mucous membrane of the nose, which is highly inflamed, and the seat of a copious, viscid, and irritating discharge. Excessive pain and soreness exist in the forehead, over the frontal sinuses, evidently from an extension of the inflammation to the lining membrane of those cavities; and for the same reason there is generally great uneasiness in the throat and larynx. The nose and cheeks soon become hot, swollen, purple, excoriated, and exquisitely painful; the discharge from the nostrils assumes a bloody, purulent character, and is both copious and disgustingly offensive; the eyelids are infiltrated and nearly closed; and the features are hideously disfigured. About the tenth or twelfth day hard pustules make their appearance on various parts of the body, especially on the trunk, face, genital organs, and inside of the limbs, resembling those of smallpox, and attended with profuse, fetid sweats. Occasionally they are accompanied by black bullæ, which, breaking, discharge a thin, sanious fluid, and bring into view gangrenous spots, varying from the size of a three-cent piece to that of a quarter of a dollar. In some cases, again, numerous tubercles appear in different situations, interspersed among the pustules, or pustules and vesicles; they are generally small, of a roundish shape, hard, and exceedingly painful; as the disease proceeds, they give way on the surface, and exude a thin, ichorous fluid. The

lymphatic glands of the groin, axilla, and other regions frequently participate in the disease, becoming enlarged, tender, and painful; the lungs are also apt to suffer, and, indeed, it is not uncommon to see serious involvement of various viscera.

As the disease progresses, the prostration rapidly increases; the fever displays a more malignant character; deep coma supervenes; and the body exhales a horribly offensive odor, almost characteristic of the disease, and strongly denotive of the dissolved state of the blood and the putrescent nature of the secretions.

The period at which death occurs varies from eight or ten days to four or five weeks. In a majority of the reported cases, the disease terminated fatally before the eighteenth day; some of the patients died as early as the end of the first week, while a few lived until after the fiftieth day.

When glanders pursues this rapid course it is said to be acute, and chronic when it is more tardy. In the former case, the local symptoms usually precede the general, frequently setting in within a few hours after the absorption of the virus. The inoculated part becomes red and tender, and the epidermis is soon elevated into a vesicle, or pustule, from which the inflammation rapidly extends along the lymphatic vessels as high generally as the glands of the groin or axilla. The swelling is excessive; the limb is stiff and numb; and the connective tissue, infiltrated with sero-albuminous exudation, before long becomes the seat of numerous abscesses. In the more severe cases, black spots appear upon the surface, indicative of the existence of gangrene. Sometimes the local disease begins in the lymphatic glands of the groin or axilla, from which it spreads over the corresponding side of the trunk, and even over the whole limb.

In contemplating the progress of this disease, it is impossible not to be struck with the resemblance which it bears to that of a dissection wound. It evidently belongs to the hemotoxic class of affections, consisting essentially in a disorganized condition of the blood and solids, paralyzing and crippling the heart and brain, and thus bringing about that typhoid condition of the system which forms so prominent a feature of the complaint.

Dissection always discloses the existence of serious lesions in the nose and internal organs. The pituitary membrane, of a deep purple or livid hue, is coated with tough, viscid secretions, studded with tubercles, ulcerated at some points, and gangrenous at others; the nose is occasionally nearly eaten away; and large cavities generally exist upon the cheeks. The frontal sinuses, larynx, and bronchial tubes are livid and excessively congested; and the lungs often contain abscesses, occupied by ill-elaborated matter, looking more like aplastic lymph than genuine pus. The heart is commonly softened. The mucous coat of the stomach and bowels is diminished in consistence, discolored, and sometimes studded with minute tubercles, similar to those observed in the nose. The pustules which exist beneath the skin and in the connective tissue among the muscles, bear a great resemblance, in the nature of their contents, to metastatic or multiple abscesses; they contain no true pus, at least not in their earlier stages, but a dense, solid, fibrinous matter, strikingly like that so generally found in pyemia and other forms of blood-poisoning.

The *diagnosis* of glanders is, in general, sufficiently easy. An inexperienced practitioner, deceived by the aching pains and soreness of the joints and limbs, might possibly mistake it in its earlier stages for rheumatism; but the occurrence of secondary symptoms would soon dispel the illusion. From the effects of a dissection wound it may readily be distinguished by the peculiar discharges from the nose, and by the character of the cutaneous eruption. The history of the case, too, will always furnish important diagnostic data. The fact that the patient has nursed or examined a glandered horse or person, will generally of itself afford strong presumptive proof of the true character of the attack. In the latter stages of the disease, the nasal discharges, the existence of pustules, abscesses, and gangrenous spots, and the horribly fetid exhalations from the body, are signs which it is impossible to mistake.

The character of the *prognosis* may be gathered, in great measure, from what precedes. The acute form of the disease is nearly always fatal. Of fifteen cases, collected by Rayer, only one recovered. The danger in chronic glanders, on the other hand, is much less. Thus, of ten cases, mentioned by the same writer, seven recovered and three died.

The *treatment* of this affection is preventive and curative. The former consists in the adoption of proper measures for destroying the poison as speedily as possible after the inoculation. With this view, the affected or abraded surface should be freely washed by holding it for a considerable length of time under a concentrated stream of water, and then thoroughly cauterized with acid nitrate of mercury, or some other active escharotic, or, what is better, effectually excised. If the operation is impracticable, and the wound is of a punctured nature, it should at once be enlarged, and then brought fully under the

influence of some caustic, otherwise a portion of the poison lurking deep in the wound may escape its contact, and thus be absorbed into the system. If a person is known to have died of glanders, the safest plan for the practitioner is to avoid a post-mortem examination, especially if there are any abrasions, however slight, upon his hands and fingers.

The curative treatment, if it deserve such a name, has hitherto been entirely unavailing. Bleeding, both local and general, purgatives, tonics, and stimulants have proved alike useless. Obviously our chief reliance must be upon the employment of supporting measures, especially quinine, carbonate of ammonium, tincture of chloride of iron, and brandy, given in large and frequently repeated doses, in combination with liberal quantities of morphia, with a view both of allaying pain and controlling gastric irritability. Infiltrated fluids and abscesses should be promptly evacuated, and the affected parts wrapped up in flannel wrung out of saturnine and anodyne lotions. The nose should be frequently injected with tepid water impregnated with creasote, carbolic acid, or tannate of iron; liquid chlorinated sodium freely sprinkled upon the body and bedclothes; the apartment constantly ventilated; and the utmost attention paid to cleanliness. To these means should be added, in chronic cases, change of air, or residence near the sea-coast.

5. WOUNDS INOCULATED WITH A PECULIAR SEPTIC POISON GENERATED IN DEAD ANIMAL BODIES.

a. *Dissection Wounds.*

Wounds contracted in the examination of dead human bodies are named dissection wounds, and are deserving of special attention on account of the severe effects which they are capable of producing. These injuries generally occur in the form of punctures, abrasions, or slight incisions, and would generally be altogether unimportant if it were not for the fact that they are often inoculated with a peculiar poison, septic in its character, and, therefore, liable, if absorbed, to contaminate both the part and system. The instruments with which they are usually inflicted are the scalpel, tenaculum, and needle, especially the latter, as it is very apt to prick the fingers in sewing up dead bodies. Not unfrequently, the inoculation is effected through the medium of a preëxisting abrasion, or scratch, of the presence of which the person may, at the time, be perfectly unconscious. It is not necessary, however, for the entrance of the virus that there should be an open wound or a denuded surface, experience having shown that it may find its way into the system through a hair follicle or even through unbroken skin, as when the hand is immersed for an unusual length of time in poisonous fluid, as, for example, during the dissection of a person dead of puerperal peritonitis.

Of the nature of the poison which produces these severe effects nothing whatever is known. It is supposed that it is generated a short time before death, during the act of dying, or soon after dissolution, and that its development is due to a vitiated state of the blood hitherto unexplained. The idea is certainly plausible, supported as it is by the circumstances that the poison is generally most virulent when it is communicated by persons dead of puerperal fever, erysipelas, carbuncle, phlebitis, pyemia, septicemia, carcinoma of the liver, and kindred affections. Punctures received in the examination of the bodies of persons who have died from strangulated hernia are peculiarly dangerous. Once formed, the poison, like the virus of chancre, becomes independent of its source. A proof of this fact was afforded me, some years ago, in the person of a young cutler, who, in sharpening a case of dissecting instruments for me, which had not been used for nearly five months, slightly pricked one of his fingers. The hand and arm soon became exceedingly painful, as well as a good deal swollen, a characteristically red line extending up as high as the axilla, the glands of which were also speedily involved in the disease. Nearly a month elapsed before he recovered from the immediate effects of the injury. A prick of the finger received in cleaning bones has sometimes been followed by severe suffering and even loss of life. It is generally supposed that a fresh body is more liable to convey the poison than one that has been kept for some time. This, however, is not always true; for in a subject which had been on hand for nearly a month, and which I dissected, in 1827, along with Dr. Temple, of Virginia, that gentleman came very near losing his life from a little puncture inflicted upon his thumb at the end of that period. It is worthy of remark that the body was that of an old woman, who had perished from the effects of tertiary syphilis, as was apparent from the extensive disease of the skull and other portions of the skeleton.

Violent effects sometimes follow the dressing of wounds, from the contact of foul and

irritating discharges, and a number instances are upon record of surgeons having lost their lives from this cause. Similar results occasionally occur during the removal of malignant growths from inoculation with the secretions of the affected structures. The health of Professor Dudley, of Lexington, suffered seriously for several years from the inoculation of his hand with the matter of an encephaloid sarcoma during the amputation of the patient's arm. Dr. Physick met with a case of death from the effects of a slight scratch with an oyster-shell. Bad effects not unfrequently follow punctured wounds caused by the fin of a fish, especially in persons of intemperate habits and of dilapidated constitution, although they are probably not of a poisoned character.

An accoucheur, a friend of mine, suffered very severely from the inoculation of two of his fingers with the juices of a decomposed child. In opening and extracting the head, he slightly scratched himself with the broken bones; in ten hours after the accident he was seized with a violent and protracted rigor, followed by vomiting and high fever; a red line soon extended up each arm as high as the axilla, and nearly a week elapsed before he regained his health sufficiently to be able to attend to business.

The period of *latency* of this poison is usually very brief, or, more properly speaking, only a short time elapses before the occurrence of well-marked symptoms; for it is extremely probable that it begins its peculiar operation upon the inoculated structures almost immediately after its introduction, although its explosive effects may not manifest themselves nearly so soon. Generally they do not come on before the end of the second day, or the commencement of the third. In one case—the most remarkable, in this respect, on record—very severe symptoms ensued within the first twelve hours, and the patient died in forty hours from the receipt of the wound. In the case of Dr. Temple, above alluded to, violent indisposition set in within less than thirty-five hours from the time of the inoculation. The accident happened late on a Saturday night, and on the following Monday morning he was taken so ill that he was obliged immediately to retire to his room, which he did not leave again for nearly two months. In the case of Kissam, a medical student, recorded by the late Dr. Godman, grave symptoms supervened in less than fifteen hours, although death did not occur until the fifth day. On the other hand, the patient occasionally remains free from suffering for a comparatively long period, as in the instance of Mr. Newby, an English surgeon, who, having received a puncture in opening the body of a child dead of enteritis, experienced no serious inconvenience until the commencement of the fourth day.

Some persons seem to be peculiarly liable to suffer from this poison. Thus, I, myself, seldom, in my younger days, while much engaged in post-mortem examinations, opened a dead body without the operation being followed by a boil upon my hand, thumb, or finger. Occasionally the consequences were more serious, the disease extending up the arm, along the course of the absorbents, as high as the axilla. Disordered health, hard study, general debility, mental anxiety, and other causes, no doubt, powerfully predispose to the development of the disease. A student who has for weeks inhaled the foul atmosphere of the dissecting room, taken little exercise, and sat up late at night, eating, perhaps, withal, very heartily, will be much more likely to contract the disease, and to suffer severely, if he be wounded, than one who has taken better care of himself.

Symptoms.—The usual point of departure of this disease is the inoculated part, from which it rapidly spreads in every direction. A smarting, stinging, or burning sensation is generally the first circumstance which attracts attention. Upon looking at the part, it is found to be covered with a little, whitish vesicle, perhaps hardly the size of an ordinary pin's head, filled with serum, and resting upon a hard, reddish base, extremely sensitive on pressure. When this vesicle breaks, as it usually does within the first twenty-four hours, a small ulcer is exposed, having a foul base, and discharging a thin, sanious fluid. The pain by this time is generally very distressing, burning, and pulsatile, depriving the patient of appetite and sleep; the sore enlarges; the swelling augments; and the part feels exceedingly hot, tense, heavy, and numb. Generally a red line is seen extending from the seat of the inoculation along the arm to the axilla, marking the course of one or more of the absorbent vessels. As the poisonous influence spreads, the whole limb becomes enormously enlarged, pitting on pressure, and exhibiting a dusky, erysipelatous appearance. With this increase of swelling there is a proportionate increase of pain, which now amounts to torture; the limb feels heavy, like a mass of lead, and is completely powerless. In bad cases the inflammation extends to the top of the shoulder, the axilla, and even to the corresponding side of the trunk.

Such is the ordinary course of the disease; but cases occur where the order of the symptoms is reversed, the poison exploding in the axilla, and thence extending up the

neck and down the side, the arm being, perhaps, almost free from inflammation, and there being no appearance, or only a very slight appearance, of disease at the seat of the inoculation. The swelling, which sometimes reaches as low as the crest of the ilium, is, at first, of a doughy character, and of a pale pink hue; but it soon becomes hard, and assumes the peculiar erysipelatous blush already described as belonging to the more common variety. The pain is generally exquisite from the beginning, and is sometimes of itself sufficient to crush the system, before sufficient time has elapsed for the formation of the distinctive pustule. Such cases, which are always fraught with danger, occasionally terminate fatally in a few days.

It is not every case of inoculated dissection wound that gives rise to general symptoms; on the contrary, in the great majority of instances the affection is entirely local, being confined to the immediate neighborhood of the original injury, diffused over the hand and wrist, or, it may be, limited to a few absorbent vessels, as indicated by the red lines extending up the limb. Under such circumstances the patient may feel a little unwell, have some headache, and want of appetite, or suffer from chilliness and aching of the limbs, but there is no serious disturbance of the general health. This will, however, be sure to occur if the virus has gained full admission into the system, the symptoms showing themselves, on an average, in from twelve to twenty-four hours. The patient, at first, has merely a feeling of depression, or faintness, with a sense of chilliness, pain in the head, and slight derangement of the digestive organs. This prodroma is speedily succeeded by violent rigors, alternating with flushes of heat, by nausea and vomiting, excessive restlessness, intense thirst, an increase of cephalalgia, a haggard, woebegone state of the countenance, and indescribable despondency. The tongue is coated, the respiration hurried, the skin dry and hot, the pulse sharp and frequent, but feeble. The bowels are either constipated, or, as more frequently happens, harassed with diarrhœa.

The disease, in its worst forms, soon reaches its crisis, the system rapidly falling into a typhoid state. During this downward course the symptoms above described become more and more marked; the tongue is dry and brown; the pulse quick and tremulous; the countenance sallow and withered; the skin yellow and covered with clammy sweat; and the suffering indescribably severe. Delirium always sets in at an early period, and is a prominent symptom throughout. Death occurs in a few days to a few weeks, according as there is overwhelming exhaustion, or depression from gangrene and metastatic abscesses.

The appearances discovered on *dissection* are variable. When the case has run its course very rapidly, the internal organs may, apparently, be entirely free from disease, or there may be evidence of slight effusion into the chest, with an engorged condition of the lungs, the affected structures themselves being somewhat infiltrated with serum and lymph. Under opposite circumstances, there will generally be marks of inflammation of the arachnoid membrane, pleura, lungs, and peritoneum, with, perhaps, deposits of pus in the larger joints, among the muscles, and in the subcutaneous connective tissue. The parts more immediately involved in the morbid action will be found to be enormously distended with the ordinary products of inflammation, highly softened at some points and greatly indurated at others, with, here and there, an abscess, and, perhaps, a gangrenous spot.

The *prognosis* of this affection may be deduced, in some degree, from the preceding remarks. When the disease is strictly local, much suffering may be the consequence, but ultimate recovery will be certain, the part immediately affected becoming, perhaps, withered and completely useless, as often happens when the lesion is seated in a finger. In the very worst cases death may occur in less than forty-eight hours, apparently from the empoisoned condition of the nervous system, with little or no evidence whatever of local disease. In another class of cases, also very bad, the patient may live five or six days, and then perish from the violence of the resulting inflammation; or he may linger for weeks and months, abscess after abscess forming in the limb, on the side, or in other regions of the body, and finally die from constitutional irritation; or, lastly, he may, after having been for a long time on the very brink of the grave, struggle through the disease, and in the end make a good recovery, or he may remain permanently weak, and crippled in some internal organ.

Some persons are a long while in recovering from apparently very trifling accidents of this kind, depending either upon some idiosyncrasy, or upon some derangement of the general health. I myself formerly suffered a great deal in this way. On one occasion my thumb, accidentally pricked in examining the body of a woman dead of phthisis, remained sore for fifteen months; and a former colleague of mine, Professor

Rogers, of Louisville, had an affection of this kind upon one of his fingers which troubled him for upwards of three years. When the disease is thus protracted, the probability is that disorder of the digestive organs is essentially concerned in nursing its latent embers.

Treatment.—The treatment is preventive and curative. As soon as a wound of this kind has been received, the part should be most thoroughly washed with warm water and Castile soap, and then subjected to a stream of cold water, followed by suction performed with the mouth. If the wound be very small, or valvular, the best plan will be to dilate it, as a preliminary step, in order to facilitate the extraction of the poison. Whatever method be adopted, the operation is completed by effectual cauterization with acid nitrate of mercury, inserted into the wound by means of a small, pointed stick of wood. In the absence of this article, which I prefer to everything else for the purpose, use may be made of nitrate of silver, butter of antimony, hydrochloric, nitric, or sulphuric acid, or a saturated solution of equal parts of alum and nitre. Persons who habitually suffer from dissection wounds should always employ some precautionary measures in examining dead bodies, such as anointing the hands well with pomatum, lard, tallow, or simple cerate, and even wearing thin leather gloves, any fluids that may be present being previously removed by an assistant. Fortunately, since the introduction of chloride of zinc injections, now in common use in our schools, inoculation in any form from dissection wounds is much less frequent than formerly. In the Jefferson Medical College, no case of a serious character has occurred since this article was first employed by Professor Wallace. The pupils of the other institutions of this city have, I believe, been equally exempt.

If the case has been neglected, or if, despite the above precautions, a vesicle forms at the site of the wound, a free incision should at once be made, when, bleeding having been encouraged by immersion in warm water, the part should be thoroughly cauterized with nitrate of silver, or brushed over with dilute tincture of iodine, an ectrotic effect being still hoped for, although not likely to be attained. Warm water-dressing with laudanum is then applied, and a brisk cathartic administered, the patient being kept strictly at rest upon light diet and carefully watched. If the disease extend, means must be employed to limit its action, and to sustain the system. In view of the inevitable typhoid tendency, all exhausting remedies must be scrupulously withheld, especially the lancet and active purgation. If nausea and vomiting are present, a mustard and salt emetic, or an emetic of ipecacuanha, is administered, and the bowels and secretions are regulated by mercurial laxatives, aided, if there be high fever, by tepid sponging of the surface, and the use of the neutral mixture. To relieve the excessive pain and restlessness, morphia must be given in large and sustained doses, united, if the skin be hot and dry, with aconite or veratrum viride. The distressing headache so often attendant upon the disease, must be treated with cold applications, the hot foot-bath, and the exclusion of light and noise; but anodynes generally afford more ease than anything else. If inflammation of the arachnoid be threatened, a few leeches may be applied to the temple, or a blister to the nape of the neck. To meet the typhoid symptoms milk punch, quinine, iron, and ammonia are indispensably necessary. In the more terrible forms of the disease, commencing with violent pain in the axilla, side, and shoulder, these means should be used at once, in large quantity, especially the brandy, with the hope of neutralizing the poison, and thus arresting its zymotic tendency. Although we know nothing of the nature of this poison, it is not at all improbable, judging from the good effects which attend the employment of alcohol in the treatment of snake-bite, that brandy and other spirituous liquors might be of great service in dissection wounds. The suggestion, at any rate, seems to me to be worthy of attention. Their beneficial effects might possibly be increased by the free use of carbonate of ammonium; certainly by that of anodynes.

As it respects the parts more immediately concerned in the disease, the best application, after the first ten or twelve hours, is warm water-dressing, medicated with laudanum and Goulard's extract, acetate of lead, or chloride of ammonium, preceded and accompanied by dilute tincture of iodine. Lint wet with oil of turpentine and laudanum sometimes affords great comfort. Blisters and nitrate of silver are objectionable, their vesicating effects interfering with other remedies. Leeches are occasionally productive of great relief, but they are not to be used, except in very robust subjects, and in the earlier stages of the affection. When there is much œdema, the pressure of the bandage will be useful. Tension is relieved, and matter evacuated, by free and timely incisions.

Covering the parts thickly with strong mercurial ointment, along the whole track of

the inflamed lymphatic vessels, is sometimes useful in arresting the spread of the morbid action, and promoting the absorption of effused fluids. Professor Wallace speaks in high terms of this mode of treatment, which is especially worthy of trial in the earlier stages of the disease.

The secondary effects of this class of injuries yield most readily to change of air, attention to the secretions, and the use of tonics, iodide of potassium, and cod-liver oil. In obstinate cases, a mild course of mercury may be necessary. The most eligible topical remedies are evaporating spirituous lotions, or solutions of acetate of lead, Goulard's extract, or chloride of ammonium. Sometimes a deep and free incision will afford more prompt relief than anything else.

Finally, it must not be forgotten that students and physicians who spend much of their time in the dissecting-room, in the dead-house, or in making post-mortem examinations in private families, are not fit to attend women in their confinement, or to dress wounds, compound fractures and dislocations, or to perform surgical operations, however simple, without previously subjecting themselves to thorough ablutions with disinfecting fluids and even, in many cases, changing their clothing. The finger nails, in particular, should be thoroughly cleansed, otherwise inoculable matter may readily be conveyed to healthy persons.

b. *Malignant Pustule.*

This is a disease, primarily, of the cutaneous and connective tissues, commencing in the form of a little vesicle, and rapidly terminating in gangrene, its cause being a septic virus generated by horned cattle laboring under murrain. The French surgeons usually describe it under the name of charbon, and in many parts of Europe it is vulgarly known by the term Persian fire, or malignant pimple, the former having reference to the horrible pain which attends it, the latter to its destructive tendency.

The disease is met with in various sections of the Union, although it appears to be less common here than in Europe. Cases of it have occasionally been noticed in this city and its vicinity, and I have myself seen it in Kentucky, where, as well as in Ohio, Illinois, Tennessee, Mississippi, and Louisiana, murrain sometimes prevails as an epidemic. In the latter State it caused great havoc in the summer of 1851, among the stock of the parishes of St. Mary and Vermillion, carrying off an immense number of cattle, as well as a considerable number of horses and mules, among the latter of which it first broke out. Hogs and dogs that ate of the carcasses took the distemper, and soon died of it. Several cases occurred in which the disease was communicated to the human subject by the green carrion-fly. During my residence at Louisville, four cases of the malady, all contracted in flaying and eviscerating cows dead of murrain, came under my observation.

In Europe, malignant pustule has hitherto been chiefly observed on the continent, particularly in France, Holland, Switzerland, Germany, and Russia. It is also very common in Siberia and South America. The inhabitants of Great Britain appear to be nearly exempt from it. In France it is most common in Lorraine, Franche-compté, Burgundy, Province, Lyonnais, and some of the other southern regions. It is rare at Paris, but frequent at Marseilles, showing that locality is favorable to its production.

The disease is most common upon the hands and face, because these parts, being habitually exposed, are most liable to inoculation. Persons who work among hides, both green and dry, tanners, butchers, shepherds, blacksmiths, and veterinary surgeons, are most liable to its attacks. It is often contracted by the common people in flaying and eviscerating animals dead of murrain. It has also occurred from introducing the hand into the rectum and vagina of cows laboring under putrid fever. The virus has occasionally been conveyed by insects from diseased brutes to man. I have already alluded to the fact that it may be communicated by the green carrion-fly. It would seem that certain parts of an animal, as the hair and wool, retain the poisonous matter for a long time, and even after they have been most thoroughly washed and cleansed. Dr. Bourgeois refers to an instance in which the disease was apparently produced by picking the horsehair taken out of an old sofa; and of eight cases reported, in 1868, by Dr. G. E. Stone, of Massachusetts, all, except one, occurred in workmen, women, or children engaged in the manufacture of curled hair. A very common way in which it is contracted is in handling dry hides. Even tanned leather is said to be capable of communicating the affection. It has been conjectured that it might be contracted by eating the flesh of brutes dead of murrain, but there are no facts that justify such a conclusion. Whether it can be conveyed from one human being to another, or from man to the inferior animals, is also undetermined.

What the nature of the *poison* is which produces this disease, or when, where, or how

it is developed, is a question which we have no means of solving. It is evidently of a zymotic character, like the virus of smallpox and chancre, and is generated by most of the domestic animals, especially cattle dead of murrain, its occurrence being less frequent in the horse, mule, ass, and sheep. It is also probable that it may be generated by birds, as the hen and turkey. In a case, of which I have collected the particulars, the disease was contracted by three persons in picking and eviscerating several buzzards with a view of extracting their oil. Both the hands and forearms of each individual were inoculated. Violent local and constitutional symptoms showed themselves by the end of the second day after the operation, the parts being excessively swollen and painful, and covered with numerous vesicles, which, upon bursting, exposed ill-looking ulcers, discharging a thin, sanious fluid, and remaining open for many weeks. The inflammation reached up to the axilla, the glands of which were enormously enlarged, some of them finally suppurating. Recovery took place only after a long time, and after great suffering, reducing the patients to the utmost degree of exhaustion. It is difficult to say whether, in these instances, the poison was actually generated by these birds, or merely conveyed by them through their feathers inoculated by carrion.

Dr. Davaine, in 1863, advanced the idea, based upon personal observation, that this disease is communicated exclusively through the agency of bacteria, which are found in the blood and lymph of the vesicles of diseased animals, and some recent investigations would seem to corroborate this view. The bacteria consist of very minute, slender filaments, cylindrical, straight, stiff, detached, devoid of motion, and capable of successive and indefinite transmission from the pustule of charbon by inoculation so long as the blood and solids retain their vitality.

Symptoms.—The period of latency of the disease is very brief, generally, perhaps, not exceeding a few hours. The first distinguishable evidence of the operation of the poison is a small reddish point, not larger than a pin's head, and the seat of a burning, itching sensation, attended with a desire to scratch. Gradually spreading in size, it is speedily followed by a little vesicle, filled with a thin, turbid serum, which, in its turn, is soon replaced by a pustule of a yellowish, brownish, or reddish color, according as it contains pure pus, or pus mixed with blood. Around the pustule is a distinct areola, not unlike that of smallpox; the part is exquisitely painful, hard, circumscribed, and easily lifted from the adjacent structures. Continuing to extend, it becomes gradually more and more prominent, until it acquires a base equal to the diameter of a twenty-five cent piece, a half-dollar, or even a dollar, and is surrounded by a zone of œdema. Meanwhile the pustule bursts, revealing a foul, gangrenous ulcer, discharging a sanious, fetid, irritating fluid, sometimes quite abundant. Long before the disease has reached this crisis, the affected limb is enormously swollen, stiff, numb, heavy, and exquisitely painful, the inflammation often reaching as far as the shoulder, and seriously involving the axillary glands. The number of vesicles is variable; in one of my cases there was only a single one: in another there were two, one on the hand and the other on the forearm; in the third there were five; and in a fourth the whole arm and hand were literally covered with them, their number amounting to several hundred. When numerous, they are always proportionately small, not exceeding the diameter of a currant or a split pea.

When the disease is seated in the face, the swelling is generally so great as to give rise to the most hideous distortion, and to render it almost impossible to distinguish one feature from another. The eyelids are closed and distended like bladders, the lips are several times their natural thickness and hardly movable, the cheeks are enormously puffed out, and the natural line of demarcation between the jaw and neck is completely obliterated. The face, in fact, looks more like a dark, shapeless mass than a human countenance. When seated here, the malady is apt to extend to the throat, causing great swelling of the palate and tonsils, attended with intense difficulty of deglutition and respiration, sometimes followed by suffocation.

The constitutional symptoms are those, in the first instance, of general malaise, or uneasiness, with a feeling of depression and foreboding of evil. Presently high fever sets in, preceded and accompanied by rigors; after which, in a very short time, the patient sinks into a low, typhoid condition, commonly attended with muttering delirium, loss of sleep, and excessive restlessness. Death often follows in three or four days from the first manifestation of the disease; but sometimes it does not take place under a week, and in rare cases not before the end of a fortnight. The patient's habits and state of health at the time of the inoculation, the quantity of matter absorbed into the system, and the nature of the treatment, all, doubtless, exercise an important influence upon the issue of the

case. As a general rule, however, it may be stated that few recoveries occur under any circumstances.

Dissection has hitherto thrown no light upon the nature of this disease. The internal organs, especially the lungs, are generally considerably engorged ; and in a few instances metastatic abscesses have been found. The affected limb is usually distended with serum and lymph, the latter of which often exists in large quantity, giving the parts their characteristic hardness, and exhibiting occasionally, here and there, a greenish, gelatinous appearance. In one case I discovered several depots of blood. If the patient survive sufficiently long, abscesses may form in the subcutaneous connective tissue, and probably even in some of the viscera, especially the lungs and liver. The inflammation seldom extends deeply among the muscles, its progress being, apparently, limited by the aponeuroses. The axillary glands are sometimes much enlarged, softened, discolored, and infiltrated with various kinds of fluids. In the immediate neighborhood of the vesicles the parts are of extreme density, cutting with a grating noise very much like fibrocartilage. Doubtless the veins and absorbents are implicated in the disease, but in what manner, or degree, has not been ascertained. There is usually, after death, a tendency to rapid decomposition.

Treatment.—The treatment is prophylactic and curative. As soon as it is ascertained that an individual has been inoculated, the part should be cut out, after which it should be well washed with warm water, to encourage vascular disgorgement, and then still further drained by the cupping glass, these means being followed by thorough cauterization with dilute acid nitrate of mercury or solid nitrate of silver. Or, instead of this, the part is destroyed with the Vienna paste, or the hot iron. When the pustule is fully formed it should be excised or destroyed ; the zone of induration should be incised and thoroughly cauterized ; and the zone of œdema, as recommended by Verneuil, should be injected with ten drops of a one-half per cent. solution of iodine. When early and effectual riddance has been neglected, or found impracticable, the treatment must be conducted upon general principles, by mild, soothing, and supporting measures. All sanguineous depletion, both by the lancet and leeches, active purgation, and other debilitating means, are avoided, as calculated, inevitably, to hasten the fatal crisis. The secretions, always seriously deranged in this disease, are rectified by small doses of calomel, the excessive pain is allayed by morphia, and the system is sustained by the liberal use of brandy, quinine, and other stimulants. The limb, placed in an easy, elevated position, is wrapped up in light flannel cloths, wrung out of a tepid solution of lead and opium, tension and throbbing being relieved by early and free incisions. Sometimes great comfort is experienced from the employment of an emollient cataplasm, covered with laudanum and olive oil. Fetor is allayed by the chlorides, which may also sometimes be advantageously given internally. During convalescence, the cure must be promoted by nutritious food, and change of air. The most efficient disinfectants of poisoned commercial hair, hides, and other articles are sulphuric acid and a moist temperature at from 140° to 150° Fahr.

CHAPTER XI

RAILWAY INJURIES.

RAILWAY injuries present so many points of interest, and differ, withal, so much from other lesions, as to demand special notice in a work of this kind. Indeed, the differences between such injuries and ordinary wounds are quite as striking as the differences between the latter and gunshot wounds, or the gunshot wounds of the present day as compared with those of former times, prior to the invention of the conical ball. Moreover, lesions of this kind are worthy of particular study, not less so on account of the frequency of their occurrence than the frightful mortality that attends them. In this country alone, where, in 1882, there are nearly 100,000 miles of railway, the loss of life, in one form or another, from these accidents, is absolutely appalling, the number of persons destroyed by them amounting annually to several thousand, while the number of those permanently maimed is vastly greater.

The lesions in railway accidents may be caused by the passage of the wheel of the carriage, by the pressure of the buffer, or by fragments of broken timber entering the

body, cutting, lacerating, and contusing the tissues, perforating the joints, and laying open the viscera. The most frightful shocks and concussions are generally caused by railway collisions, in which the passengers are thrown forcibly from their seats against such objects as may happen at the moment to be near them, the violence of the injury being generally in proportion to the speed of the train. Frightful accidents, attended with excessive injury of the soft parts and the bones, as well as extreme shock, placing limb and life in jeopardy, are of frequent occurrence from the passage of the wheels of street cars.

Railway injuries may, like injuries from other causes, be limited exclusively to the soft parts, or, as is most generally the case, they may involve both these structures and the bones, the latter, indeed, often suffering in a far greater degree than the former. In extent they may be slight, on the one hand, or, on the other, so severe as to prove fatal, either instantaneously, without any attempt at reaction, or secondarily, as the result of inflammation and its consequences. In their character they may simply exhibit the features of a contusion, or they may occur in the form of a wound, either open or subcutaneous, most generally the former, contusion and laceration preponderating. Beside these peculiarities, railway injuries are further distinguished from the more ordinary lesions by excessive shock and concussion of the nervous system, by the small amount of hemorrhage, by the impossibility of procuring union by the first intention, by the frequent necessity of amputation, and by the great liability to erysipelas, pyemia, and osteomyelitis ; all concurring to impart to these accidents distinctive features.

These lesions may be grouped, according to their effects, under different heads : 1st. Cases that are instantaneously fatal, or that soon become fatal, either from shock and concussion, or from the combined influence of shock and hemorrhage ; 2dly. Cases in which reaction occurs, followed by recovery, or by death from exhaustion, inflammation, erysipelas, or pyemia ; 3dly. Cases of incomplete recovery, some parts remaining permanently incapacitated ; 4thly. Cases in which remote effects, as epilepsy, hysteria, paralysis, loss of memory, morbid sensibility, or insanity, manifest themselves, perhaps not until a number of months or even several years after the infliction of the primary injury.

1st. In the worst forms of railway injury, death may be due solely to the violent concussion, not of the nervous system merely, but of the entire body, every organ and tissue feeling its baneful influence. In such a condition there may perhaps not be any outward evidence of injury, not even, it may be, a scratch upon the skin, although generally the injury sustained both by the soft parts and the bones is very great. In some of the more severe cases, the local injury is associated with extensive rupture of the capillary vessels. Thus, in one recorded by Mr. Hill, numerous vascular points, the size of a pin's head, and, here and there, minute clots, existed in the muscles of the head, chest, and abdomen, as well as in the brain, heart, lungs, liver, spleen, and kidneys. The blood, under such circumstances, is of a semifluid, black appearance, very much as in death from lightning. In fact, the whole train of morbid phenomena is such as clearly shows that death was occasioned by the sudden, total abstraction of nerve fluid. Such accidents find their counterpart in injuries caused by falls from a great height, as a tree or a scaffold, producing death instantaneously by concussion of the whole body.

Excessive shock is often conjoined with more or less serious hemorrhage. The largest bleeding usually occurs in injuries of the extremities, attended with laceration of the principal vessels, as the femoral, popliteal, or tibial arteries and veins ; but, now and then, as in railway lesions of the chest or abdomen, large quantities of blood may be poured out into the splanchnic cavities, thus greatly complicating the case, and rendering it more surely fatal.

Intense shock, rapidly terminating in death, may result from injury of a single organ, as the brain, heart, or lung, the rest having in great degree escaped. Such accidents find their counterpart in death from a blow or kick on the stomach. Or, the viscera may be free from injury, and the fatal shock be due solely to the extensive lesion sustained by the external parts, as those, for instance, of the lower extremity, the skin, muscles, vessels, and nerves being mashed and pulpified, the large joints torn open, and the bones crushed and ground to powder.

2dly. Shock, although very violent, is often followed by reaction, even when there is very grave injury, in the same manner as in concussion of the brain from falls and blows on the head. In the generality of cases, the reaction is slow, twelve, twenty-four, or even forty-eight hours elapsing before it is fully established, the system frequently faltering in the interval even under the sustained employment of the most powerful stimulants. Or, the reaction, after various efforts, at length fails, and fatal collapse ensues. Some

times the system rallies sufficiently to admit of the removal of the injured structures by the knife, the patient, if there has been much shock or loss of blood, either dying under the operation or soon after; or, if he survive the immediate effects, standing a fair chance of perishing from fever, erysipelas, or pyemia. Experience has proved that amputations performed for severe railway injuries afford a very high rate of mortality, far greater, indeed, than after almost any other class of lesions, those made by the round ball not excepted. The stump, in such cases, is not unfrequently assailed by erysipelas, osteomyelitis, or even gangrene, the disease either causing death or necessitating further operative interference.

If an attempt be made to preserve the injured structures, the surgeon will run great risk of losing his patient by the violence of the resulting fever, erysipelas, gangrene, septicemia, pyemia, or profuse suppuration, death generally supervening within the first five, eight, or ten days. Railway wounds never unite by the first intention; and in most cases, even when the contusion and laceration are comparatively slight, some degree of sloughing is almost inevitable.

The symptoms of shock in railway accidents do not differ from those of shock produced by ordinary causes. When the accident has been uncommonly severe, as when a man is knocked down by a train in rapid motion, the patient is frightfully collapsed, the pulse and breathing are hardly perceptible, the countenance is of a deadly pallor, the pupils are widely dilated, and the surface of the body is covered with cold sweat. These symptoms often exist when there is no evidence whatever of local injury.

3dly. Incomplete recovery after railroad accidents is of very frequent occurrence, and may manifest itself in a great variety of ways, depending upon the nature of the injury and the character of the organs or structures involved. Thus, special sensation is often impaired in accidents involving the base of the brain, as shown in the loss of the sense of smell, taste, sight, or hearing. Paralysis of an arm or of a leg, or even of one side of the body, may be caused by a severe wrench or twist of the spine, eventuating in direct pressure by displaced bone, or indirect pressure by effusion of blood. Atrophy of a part of a limb, or even of an entire limb, is by no means uncommon; sometimes a joint is permanently disabled; and contraction of the muscles and tendons may be mentioned as another effect that properly falls under this head. The speech is occasionally considerably impaired, being weak and indistinct; and various anomalous symptoms are often present, as confusion of ideas, a sense of cold or of unnatural heat about the head, inability to attend to business, a pinched expression of the face, and a withered condition of the whole body. Occasionally, especially after injuries of certain nerves, there is a feeling of numbness, of formication, or of pricking, as if pins and needles were moved about in the parts. These and similar effects may be the sequences of the slightest as well as of the most violent injuries.

4thly. Remote effects, coming on at a variable period after the primary, not unfrequently follow upon railway accidents. These effects manifest themselves in various degrees as well as in various forms; sometimes in one manner, and sometimes in another, from the slightest departure from the normal condition of an organ to the complete perversion of its functions. The exciting cause is more commonly a slight than a severe one, the patient, after having suffered from shock, having, perhaps, made a rapid recovery, or so nearly regained his mental and physical vigor as to be able in a short time to resume his accustomed occupation as if nothing had happened to him. By and by, however, generally after the lapse of several months, without any assignable cause, his general health gives way, or he gradually loses his control over some particular organ. The approaches denotive of these occurrences are usually very stealthy and insidious, and hence, long before the patient is made fully sensible of their import, the most serious pathological changes may take place at the seat of the original lesion; changes which, if correctly interpreted at the time, might have easily been prevented, but which, now that they have acquired the ascendency, may lead to fatal, or, if not to fatal, to permanently ill consequences. Most of these remote effects are referable to injuries of the nervous system, more especially to those of the spinal cord and of the base of the brain, manifesting themselves in various forms of functional derangement and in impairment of the circulation and nutrition either of the entire body or of some particular part.

Among the more common and distressing of these remote effects are various uneasy sensations in the head, as a feeling of numbness, dizziness, weight, and tension, as if a hoop were firmly stretched around it. Occasionally there are shooting pains, or pains seated at some particular spot, more or less tender on pressure; a throbbing feeling is not uncommon; various kinds of noises are complained of; the mind is peevish and irritable;

the ideas are confused; the sleep is disturbed by harassing dreams; volitional power, mental and physical, is greatly at fault; the patient is often very emotional, frequently bursting into tears, and he is unable to apply himself to business, the slightest effort of the kind being attended with an aggravation of suffering. The organs of the special senses are frequently affected, as is evinced by the impairment of the function of smell, hearing, taste, and sight. The speech is rarely much, if at all, involved. Marked strabismus occasionally exists. The countenance has a contracted appearance, and an uneasy expression, the person often looking much older than he actually is, or than he did before he was hurt. The pulse is generally small, and somewhat above the numerical standard; the breathing is short and abnormally frequent; the digestive organs are deranged, the appetite being irregular, and the taste more or less vitiated; the bowels are constipated, and, as assimilation is impaired, the patient loses weight and strength. The kidneys and the bladder usually act naturally, but the sexual functions are often very deeply implicated, and in some cases the individual is completely impotent. Paralysis often exists, more generally in the inferior than in the upper extremities, sometimes on one side and at other times on both; in various degrees, from slight failure of motor power to total loss, occasionally associated with defective sensation, and usually coexistent with loss of temperature and clammy perspiration. In many cases the loss of power is confined to special muscles and tendons, which, in consequence, soon become permanently shortened and contracted, leaving the patient in a weak, tottering condition, and extremely liable to fall. More or less wasting of the affected limb generally occurs, amounting occasionally, in the more advanced stages of the complaint, to the most degraded atrophy. Among the more uncommon of the remote occurrences after railway accidents may be mentioned mental imbecility, epilepsy, and insanity, coming on, perhaps, at the end of several years, long after the patient had apparently completely recovered from the immediate effects of the injury.

It is generally very difficult, if not impossible, to refer these effects to their true sources; it is reasonable, however, to suppose that in the great majority of cases they are essentially due to changes effected in the cineritious substance of the cerebro-spinal axis by inflammatory irritation. Occasionally the immediate cause undoubtedly is an effusion of plasma, or of this material and of serum, of serum alone, or of blood, either in a fluid or solid state, poured out at the time of the accident, remaining unabsorbed, and by its pressure interfering with the transmission of the nerve current.

The prognosis in these secondary affections must necessarily depend upon the circumstances of each individual case. If, after they have remained stationary for some time, or if, after various fluctuations and changes, there is a gradual but decided improvement in the symptoms and the general condition of the patient, strong hopes may be entertained of ultimate restoration; the progress to health must, however, necessarily be slow, and it will be well, in order to guard against disappointment, to look for occasional interruptions. Now and then a case occurs in which the improvement is steady and persistent. The prognosis may be considered as unfavorable when there is a progressive increase of the local distress along with a gradual failure of the general health, the more especially when the downward tendency is due to great involvement of the cerebro-spinal axis, as indicated by loss of muscular power and perverted sensation. As it respects the continuance of life, the patient may last for many years, and eventually die of some intercurrent disease.

In the *treatment* of railway injuries four distinct indications are presented: to relieve shock, to arrest hemorrhage, to prevent undue inflammation, and to guard against the occurrence of secondary effects.

In the treatment of shock the same general rules are to be observed as in shock from any other cause; the usual management being by recumbency, cold water, sinapisms, the smelling-bottle, stimulating injections, and, if the patient can swallow, by the exhibition of brandy and ammonia. Overaction is prevented by morphia and the neutral mixture in conjunction with veratrum viride and other suitable measures.

Hemorrhage is controlled by ligature, torsion, acupressure, and styptics. Any wound that may exist is dressed and treated in the usual manner. If the injury occupy an extremity, and is so excessive as to demand amputation, the operation should be performed as soon as reaction has been sufficiently established to enable the patient to bear the shock and loss of blood, the limb being always removed some distance beyond the apparent seat of the lesion, lest some of the bruised and lacerated tissues being left, gangrene may seize upon the stump. If the system has only partially rallied, anæsthetics should be dispensed with, the knife then often acting as a salutary stimulus, favoring reaction and increasing the chances of recovery.

Inflammation must be limited by the usual means, opium being freely given to control the heart's action, to tranquillize the system, and to promote sleep; the secretions are corrected with blue mass; and the heat of the skin is allayed by mild diaphoretics, and by sponging the surface frequently with tepid water containing a little alcohol and vinegar. Quinine and tincture of iron are freely administered, if there has been much loss of blood; cooling drinks are used; the temperature of the room is properly regulated; and milk punch, beef essence, and the different kinds of broths are relied upon to sustain the system.

Convalescence is carefully watched, any untoward occurrence being promptly met by appropriate measures. Local irritation is combated by leeches and blisters, aided by rest and elevation of the affected part. Bodily and mental excitement must be avoided, the bowels and secretions duly attended to, and the diet properly regulated. Involvement of the lungs and other internal organs must be guarded against by more than ordinary vigilance. If secondary effects ensue, a mild course of mercury will be indicated, the remedy in many cases being advantageously given in union with iodide of potassium. Slight ptyalism, steadily maintained for several consecutive weeks, is sometimes required. In these chronic affections great benefit is often derived from the use of the cold shower-bath, change of air, mild tonics, and the judicious application of electricity.

CHAPTER XII.

EFFECTS OF INJURIES UPON THE NERVOUS SYSTEM.

Under this head may be considered the more immediate effects of injuries, as nervous depression, or shock, and, as it has not inaptly been termed, traumatic delirium. These effects may succeed to almost any lesion, however trivial or complicated, their production being greatly influenced by the temperament, habits, age, and idiosyncrasy of the individual; and they deserve the most careful study, inasmuch as they are frequently followed by the worst consequences. The subject of tetanus might properly be included under the present division, but as this disease occasionally arises without any external injury, the discussion of it will be postponed until I come to speak of the affections of the nerves.

SECT. 1.—PROSTRATION, COLLAPSE, OR SHOCK.

Shock is a depression of the vital powers, induced suddenly by external injury, and essentially dependent upon reflex paralysis of the entire circulatory system, but especially of the heart and abdominal vessels. It bears, in effect, the same relation to the nervous system as syncope to the vascular; in the one case the result is caused by inhibition of the vasomotor centres, in the other by a diminution of blood; in both, the consequence is more or less prostration, with perturbation of mind and body, extremely variable both as to intensity and duration. When the nervous shock is severe, it may instantaneously terminate in death, as so often happens in falls and blows upon the head; more generally, however, after having continued for an indefinite period, it passes into reaction, the powers of life gradually coming up, as the different organs and the general system regain their nervous fluid. The most severe and fatal cases of shock are generally those that supervene upon direct injury to the great nervous centres, as the brain and spinal cord; no less disastrous effects occasionally succeed blows upon the epigastric region, in consequence of the violence thus inflicted upon the solar plexus of nerves. In some of these and similar instances life is destroyed with the same rapidity as by lightning, the nervous fluid being instantaneously annihilated without the individual being rendered conscious of his doom. Such cases have their counterpart in those frightful hemorrhages in which, a large artery, as, for example, the aorta, being divided, the patient perishes in a few seconds from loss of blood. The blood is a vital fluid, the integrity of which is indispensably necessary to the well-being of the system and the maintenance of healthy action. But it is certainly not the only fluid entitled to this distinction; the nervous fluid is both more subtle and more important as a life preserver. When blood flows away in a mighty and overwhelming torrent, the person dies, and life is then said to be destroyed, as it certainly

is, by the excessive sanguineous drainage. But in shock, the same effect may happen, and yet the body be literally surcharged with blood, not a single drop, perhaps, having been spilled in the accident causing the fatal result. Thus, of the two fluids, the nervous is, in every respect, the more important, because the more essential to life; and its disturbance is, therefore, a more frequent cause of death.

Shock may be produced by a great variety of *causes*, some of a bodily, others of a mental, character; some external, others internal. It may be purely nervous, or partly nervous and partly hemorrhagic, that is, dependent upon the conjoined loss of the nervous and sanguineous fluids. The nature and extent of shock are greatly influenced by the state of the general health at the time of the accident, the amount of the injury, the importance of the part more directly assailed, and, also, in an especial manner, by the idiosyncrasy of the individual. There are some persons, soldiers, for example, of the most undoubted courage, men who would not hesitate to face the mouth of the cannon, who fall into a state of the most profound prostration from the most trifling accident; who turn pale and tremble like a leaf; whose minds are perfectly bewildered, and who are, as it were, completely stunned, from injuries so insignificant as not to effect, in the slightest degree, ordinary persons. Such an occurrence can only be explained by a reference to idiosyncrasy; and it has its counterpart in those persons who, although extremely plethoric, faint from the slightest loss of blood, or even from the mere sight of that fluid. There are other persons, on the contrary, whom hardly any accident, however severe, can shock; they are insensible to pain; their nervous system is obtuse; nothing affects them, either bodily or mentally; a severe blow may stun them, but the impression is transient; in a few minutes they are completely restored to consciousness and power. Here, again, is an example of idiosyncrasy, a peculiarity of organization; in the former case, the individual is all nerve, all sensibility; in the latter, all blood, all muscle. But it is not only the nervous and irritable that suffer from shock; the fat and corpulent are prone to be affected by it from the slightest causes, and hence such persons seldom make good subjects for the knife; they bear the loss of blood badly, and are extremely liable to perish from erysipelas and pyemia, in consequence, as it appears to me, rather of loss of nervous fluid than from any toxic state of the blood, or blood-poisoning, properly so called. There are some individuals whom the slightest operation will kill; touch them, and they are sure to die; they are destitute of life power, and incapable of resisting the slightest shock. The fainting produced by the pricking of a needle and the introduction of a bougie affords a familiar illustration of shock from trivial causes.

Among the external causes of shock deserving of particular notice, on account of their crushing effects, are injuries of the skull and spine, such, for example, as are produced by a fall or blow; gunshot, railway, steamboat, and factory wounds; dislocations and fractures; violent sprains, burns, and scalds; and some of the more severe operations, as the extirpation of enormous tumors, and the amputation of the larger limbs, even when not attended with any considerable hemorrhage. The extraction of a tooth, in a very nervous person, has been known to occasion fatal shock.

Severe shock is frequently produced by internal causes. One of the most familiar examples of this kind is afforded in perforation of the bowel, consequent upon typhoid fever, and followed by extravasation of fecal matter. The moment this takes place, the shock is immense; if the patient had been struck severely on the head, it could not be more so; in some cases it is so overwhelming as to destroy life in a few hours. The pain which attends the passage of a gall-stone, or of a renal concretion, is often followed by similar results; extravasation of urine may be mentioned as another illustration. Many a woman has perished from shock induced by severe labor; and the excessive prostration consequent upon apopleptic seizures is familiar to every practitioner.

The occurrence of shock is more or less influenced by the state of the system. Whatever undermines the vital powers renders the system less capable of resisting an effect of this kind, and should be duly considered in weighing the prognosis after a severe injury, or the probable consequences of a severe or protracted operation. Shock is never borne well by persons laboring under organic disease of the heart, liver, or kidneys, and for this reason they are, as a rule, unfit subjects for the knife. Children and old persons suffer, other things being equal, more disastrously from shock than persons in the prime and vigor of life. General debility, intemperance, anemia, and debauchery of any kind exercise an unfavorable influence, and often sadly interfere with reaction. The location of an injury often exercises a remarkable influence upon the degree and duration of shock. Compound fractures and dislocations and gunshot lesions of the splanchnic cavity and of their contents are often followed by severe and long-continued, if not overwhelming

shock ; but of all depressing effects of this kind, and the one most surely fatal is that consequent upon extensive scalds and bruises, in which the collapse is widespread and complete, often unattended even by the faintest possible show at reaction.

Mental shock is often extremely severe, and is occasionally followed by the worst consequences, especially when it occurs during the progress of a severe illness, or after a severe surgical operation. Fright is perhaps the very worst of the causes of mental shock. The effect of terror, in suddenly exhausting nervous power, is well illustrated by the history of those persons, who, sentenced to be bled to death, actually died on hearing water trickling into the basin, which they supposed to be blood issuing from their veins, after the arm had been slightly pricked, although no vessel had been opened. It is related of Desault that he one day lost a patient, about to be lithotomized, from sheer fright. The man, who was very cowardly, fainted and died under the impression that the operation was progressing, when this distinguished surgeon was, in fact, only tracing with his nail the line of the intended lesion on the perineum. A sick, bedridden person, in danger of being burnt to death, has been known to perish from shock brought on by excessive mental trepidation. The receipt of disagreeable news, the sudden loss of property, and, in short, violent mental emotion of almost any kind, may give rise to similar effects.

Mental and corporeal shock are often combined ; and it is then not uncommon to see the former preponderate, in a very marked degree, over the latter. The soldier on the field of battle may suffer from bodily shock induced by a severe wound ; he may feel that he is badly hurt, but still he is sanguine of recovery, and cheerfully and manfully bears up under his affliction. The surgeon examines his wound, and, perceiving its grave character, informs him that it will probably cost him his life. Instantly the case assumes a different aspect ; the system is overwhelmed with perturbation and excitement ; the vital powers are depressed to the utmost ; and death takes place, perhaps, several days sooner than it would otherwise have done. In railway accidents, caused by the collision of the cars, this combination of mental and physical shock frequently exists in an astonishing degree, sometimes affecting large numbers of persons simultaneously. Here the shock is the result evidently not of mere concussion of the cerebro-spinal axis, but of the whole body and mind as well.

The *symptoms* of shock, although extremely variable, are generally such as attend syncope from loss of blood, or concussion of the brain, which is itself only a form of nervous depression, or expenditure of the vital forces. If the accident has been slight, the effect will be that of a moderate stun, that is, the patient will experience some degree of mental confusion, look pale, and feel weak and tremulous ; objects will appear dark to him, and he will probably reel, if not fall. Presently, however, especially if he lies down, reaction will take place, and in a short time he will recover both his mental and physical powers, so as to be able to converse, act, and walk in the same manner as before he was hurt. When the injury has been severe, the effect upon the nervous system will, of course, be proportionately greater. The patient, unable to support himself, falls to the ground, often, as he does so, inflicting serious violence upon his person. Consciousness, special sensation, and volition are, perhaps, completely abolished ; the countenance is deadly pale ; the respiration is slow and feeble ; the pulse is small, fluttering, and, at times, altogether imperceptible ; the extremities become rapidly cold ; and the surface is soon bathed with an abundant, clammy sweat. Gasping and sighing, with convulsive tremors, are often present, generally but too clearly denoting the serious character of the lesion. Not unfrequently there are involuntary discharges from the bowels, with nausea and even vomiting.

The duration of these symptoms is subject to no little diversity ; at times they pass off in a few minutes, or, at furthest, in a few hours ; at other times they last for several days, and even then, perhaps, they do not disappear entirely, one or more persisting for a considerably longer period. When the shock is very severe, death may occur instantaneously, or the case may linger for some time in a state of doubt and uncertainty, with, now and then, an attempt at reaction, and at last prove fatal. Instances occasionally occur in which, after tolerably complete reaction has been established, the system sinks again into a partial state of collapse, the vital forces evidently having not sufficient stamina to maintain the functions of the brain and heart. Such cases are very liable to end fatally, generally within the first twenty-four hours after their occurrence.

Reaction, after shock, is denoted by a gradual, or more or less rapid, resumption of the functions of the different organs, which awake, so to speak, from their slumber, and spring back again into life and happiness. One of the first evidences of this change is a return of the color of the face, with an increase of the heart's action, as indicated by the state

of the pulse, which is not only stronger and fuller, but more steady and regular ; the respiration is more free and open ; the surface becomes warmer and dryer ; the sphincters again obey the will ; and the mind regains its self-possession and power of action. Often the first symptom of reaction, after severe shock, is vomiting, followed by complete clearance of the contents of the stomach, itself generally a favorable sign, as it is often denotive of a return of muscular power.

There is a form of shock which has been, not inaptly, called insidious, as the symptoms are generally of a masked character, and are, therefore, well calculated to deceive both the patient and practitioner. The person, although severely injured, congratulates himself upon having made an excellent escape, and imagines that he is not only in no danger, but that he will soon be about again ; in fact, to look at him, one would hardly suppose, at first sight, that there was anything serious the matter ; the countenance appears well, the breathing is good, the pulse is but little affected, except that it is too soft and frequent, and the mind, calm and collected, possesses its wonted vigor, the patient asking and answering questions very much as in health. But a more careful examination soon serves to show that deep mischief is lurking in the system ; that the machinery of life has been rudely unhinged, and that the whole system is profoundly shocked ; in a word, that the nervous fluid has been exhausted, and that there is not enough power in the constitution to reproduce and maintain it. The skin of such a person assumes an icterode, or sallow, cadaverous appearance, feeling at the same time doughy and inelastic ; the extremities are deadly cold ; the pulse makes a desperate effort at reaction, but is, at best, weak and tremulous ; there is little or no pain ; and the patient is altogether too composed and tranquil for one who has sustained such an amount of violence. The system does not seem to be conscious of what has occurred ; its sensibilities are blunted, and it is incapable of suffering. Nature, to use the language of Hunter, does not feel the injury.

The countenance, in this form of shock, has often a peculiarly, melancholy expression, as if foreshadowing the fatal event ; a sad smile plays upon the lips, and illumines the lower part of the face, while the upper part wears a gloomy aspect, in striking contrast with the other. The forehead, as the patient looks at his attendants, especially if he has just been roused from sleep, is strongly knit and wrinkled, giving it a scowling and sinister air. As the case progresses, the brain gradually sinks into a comatose condition, the signs of prostration become more pronounced, and death finally occurs from mere exhaustion, life seldom lasting longer than three or four days.

The *treatment* of shock must be conducted with two objects in view, to promote reaction, and to moderate supervening inflammation, for to prevent it altogether is by no means always possible.

A patient affected with shock should immediately be placed recumbently, all constriction should be removed from his person, free access of cold air should be provided, cold water should be dashed upon the face, smelling-bottles should be passed to and fro under the nose, and sinapisms should be applied to the extremities and to the precordial region. If the case is unusually severe, with a decidedly downward tendency, atropia or tincture of digitalis should be injected under the skin, stimulating injections should be thrown into the rectum, and turpentine rubbed along the spine. If deglutition is practicable, brandy and water should be given, but in trying to convey these or any other fluids into the stomach, great care must be taken, otherwise they may descend into the windpipe, and so cause strangulation. The most prudent plan, in such a condition, is to introduce the drink with a spoon, the mouth being previously forced open, and a powerful effort made to excite the patient's attention by hollowing loudly into his ears. If he cannot swallow, no attempt should be made at compulsion, but, for the reasons just mentioned, the effort should at once be discontinued. Stimulants, especially alcoholic, should never be given in large quantities at a time. Teaspoonful doses, administered every five, ten, or fifteen minutes, are, as a rule, much more efficacious and reliable than larger quantities, the only effect of which, at least in many cases, is to add still further to the depression of the system, and, consequently, to render reaction more difficult, if not impracticable. The hypodermic injection of a fourth of a grain of morphia occasionally greatly promotes respiration.

In the milder cases of shock, the most simple treatment often suffices to bring about reaction, as the recumbent posture, a drink of cold water, and the use of the fan and smelling-bottle. The blood and nervous fluid soon resume their wonted channels, and the vital forces rapidly regain their supremacy.

In the mental form of shock, a soothing word, or an assurance of the absence of danger, often goes further in promptly effecting restoration than the most powerful stimulants, steadily and regularly administered. Persons suffering from this variety of prostration

are frequently much more frightened than hurt, and promptly regain their animation and self-possession on being told that their injuries are altogether of a simple, trivial character, devoid of all danger, both present and future.

Occasionally reaction is sadly interfered with by an overloaded and oppressed stomach, as when the accident occurs soon after a hearty meal. In such cases, the patient often lies in a state of deadly pallor, with more or less retching, for hours, before he can shake off the oppressive burden. The indication obviously is to assist nature in her efforts at emesis, by the administration of a dose of alum, ipecacuanha, or sulphate or zinc, or, what, perhaps, is better, under such circumstances, equal parts of common salt and mustard, or mustard alone. Serious lesion of the brain is hardly to be considered as a contraindication to such a course, when it is recollected that the digestive powers are completely suspended, and with what difficulty reaction takes place when the stomach is oppressed by a heavy meal.

The silly and reprehensible practice of bleeding persons laboring under the exhaustion of shock, once so common, has happily become obsolete. No surgeon should do anything without a reason, and it is, therefore, difficult to perceive what could ever have induced a procedure so contrary both to physiology and common sense. In the opinion of the vulgar, there are no cases in which it is not proper, immediately after such an accident, to draw blood from the arm; but assuredly no practitioner would yield his judgment to such an erroneous view, and perform an operation that might speedily prove destructive to his patient. Fortunately, whenever such an attempt is made by the ignorant and thoughtless charlatan, the blood generally refuses to flow, and consequently no harm is done.

The second indication is to moderate the resulting inflammation. To do this, much may be accomplised, in the way of prevention, by letting on the reaction gradually; avoiding, on the one hand, the undue use of stimulants, and, on the other, cautiously interposing antiphlogistics as occasion may arise for their exhibition. Proper allowance is made for the apparent violence of the symptoms, the excitement without power; the struggle may be furious, but will in all likelihood be brief, for, if the previous depression has been at all severe, the flame will ere long cease of its own accord, or readily yield to the influence of very simple means. such, for instance, as sponging the surface frequently with cool or tepid water, and administering a little morphia and antimony, aided by rigid abstinence, and perfect tranquillity of mind and body. Bleeding should be practised only in young and plethoric subjects, with a tendency to serious inflammation of some important internal organ, and where, consequently, the fire is real, not feigned. The opposite course often exerts a most pernicious influence upon the patient's recovery; impairing his vital powers, and preventing the system from keeping up a due supply of healthy nervous fluid, so conducive to the restoration both of the part and system. As the secretions are commonly materially deranged in all cases of severe shock, early and effectual means should be adopted for their correction and improvement; a gentle mercurial purge will often admirably fulfil the indication, and render any further use of this class of remedies unnecessary. The diet for the first few days should consist mainly of animal broths, conjoined, if necessary, with milk punch, or wine whey, and cautiously followed by food of a solid and more substantial character. Starvation, in cases of severe shock, is not to be thought of. Such a course cannot be too pointedly or too forcibly condemned, as it is contrary alike to sound sense and the dictates of an enlightened experience.

Anodynes are always borne well after severe shock, and should be administered early and freely, to allay vascular action and tranquillize the nervous system. The most suitable article is morphia, or the ammoniated tincture of opium, either alone or conjoined with valerian, the latter remedy being especially serviceable in nervous, hysterical persons, or what is far better, bromide of potassium. If the vital powers sensibly flag after the occurrence of reaction, recourse must be had, in addition to anodynes, to quinine, carbonate of ammonium, and brandy, liberally and diligently administered. Determination to internal organs is met by leeches, blisters, and other counterirritants.

SECT. II.—TRAUMATIC DELIRIUM.

One of the most unpleasant effects with which the surgeon has to contend in the treatment of wounds and other injuries, as well as after surgical operations, is the occurrence of delirium, at a period too, perhaps, when everything is apparently progressing in the most favorable and gratifying manner. All of a sudden, the nature of the case undergoes a remarkable change for the worse; the horizon, just a moment before perfectly calm and serene, like a summer's sky, is almost instantly overcast by a dark, lowering cloud;

the system is thrown into nervous tremors, and the mind, agitated with disagreeable forebodings, is absorbed in some peculiar fancy, in which the patient imagines himself pursued by his enemies, or annoyed by persons peeping at him through the keyhole of his door, making grimaces at him through the window, or concerting measures for his destruction. Great diversity obtains in respect to the manner in which the disease is ushered in. In some cases the symptoms are apparently of a hysterical character, the patient laughing and talking in a loud, boisterous, and incoherent manner; or perhaps indulging in unmeaning jokes about the nature of his disease, the manner in which he was hurt, or the conduct which he exhibited during the operation he has undergone. In another class of cases, by no means uncommon, he is completely absorbed in his business; he harnesses his horses, hitches them to the carriage, and swears at them because they do not move to please him. In some cases, again, he is seized with a species of religious frenzy; he prays and sings, and utters pious exclamations. Occasionally, he labors under some demoniacal delusion; he fancies that the devil has possession of him, and that he is about to be carried to the infernal regions. Finally, there are instances in which the patient is sadly annoyed by the idea that he is pursued by snakes, dogs, or rats, or that some horrible reptile is trying to creep into his throat. In short, there is no end to these delusions, which are often as ludicrous to the observer as they are distressing to the patient, to whom they are always a source of severe suffering, not less so than if they were real.

The cause of these symptoms is not always apparent. In the great majority of cases, they are produced, either directly or indirectly, by the inordinate use of alcoholic spirits, suddenly interrupted by the occurrence of a severe injury, attended, it may be, by dreadful shock or copious hemorrhage, thus greatly increasing the susceptibility of the nervous system to external and internal impressions. It is not necessary for their development that the individual should have been an habitual drunkard; they often show themselves nearly as readily if he has merely been a free drinker without having carried the use of liquor to the extent of intoxication. On the other hand, they occasionally occur in persons of the most temperate habits, who have, perhaps, never used alcohol in any form, or for any purpose whatever. Dupuytren, who first called attention to this variety of the disease, has given it the name of nervous delirium, and in the paper which he published on the subject he has reported a number of cases in which it supervened upon various kinds of injuries and operations, some of them of a very trivial character, or such as usually produce no unpleasant results of any description, the patient rapidly recovering from their effects. It cannot be doubted that, in these cases, the affection is generally of a purely nervous nature, arising from the effects of the commotion inflicted upon a delicate and highly susceptible constitution. Under such circumstances, it is often mixed up with the effects of shock, rendering it difficult, if not impossible, to distinguish them accurately from each other. All practical surgeons have frequent opportunities of witnessing such cases. So far as my observation extends, I am not aware that any class of injuries is entirely exempt from the disease; sometimes the most trivial scratch or contusion is followed by it. Corpulent persons, who generally bear injuries and operations very badly, are particularly liable to this form of delirium. Burns and scalds, railway lesions, lacerated wounds, and compound fractures may be enumerated as among the more powerful causes of the affection. It has been thought that children are less liable to suffer from nervous delirium than adults and elderly subjects, but this is certainly not true; on the contrary, such is the susceptibility of the system at this tender age to physical and mental impressions that the slightest accident is often sufficient to develop it. If women are less frequently affected than men, it is simply because they are less exposed to the various exciting causes of the disease. There is certainly every other reason why they should suffer quite as much as men, if indeed not more.

Nervous delirium generally comes on within the first twenty-four or forty-eight hours after the application of the exciting cause: it may last for a variable period, but rarely longer than five or six days, and may terminate either in health or in death, according to the gravity of the injury that has produced it. Its leading symptoms are a confused, wandering, or flighty state of the mind, with excessive vigilance; incoherency of speech and manner; absence of fever; an open, moist state of the skin; and little or no excitement of the pulse. The eyes have generally a wild expression, and the patient is easily disturbed by noise and light; as well as by the presence of his attendants. The appetite is usually impaired, the bowels are costive, the urine is scanty and rather high-colored, and the feet are disposed to be cold. If the patient be spoken to, he is generally readily roused, but soon lapses into his former condition.

Nervous delirium properly so called, is easily distinguished from delirium tremens by the

absence of tremors, which form such a striking feature in the latter disease as to be characteristic. In delirium tremens the limbs are always in a tremulous condition; the symptom comes on early in the attack, and generally lasts until the effects of the disease are nearly worn off. When the delirium is fully developed, the hands and fingers are incessantly in motion, the patient carrying them to his mouth, face, and head, as if he were desirous of swallowing something, or removing some imaginary object from his person. The countenance is usually flushed, the eyes are deeply injected, the pulse is small, frequent, and quick, and the mind is roused with difficulty. Added to these circumstances is the history of the case, which generally affords valuable, if not conclusive, information respecting the patient's habits prior to his attack.

Delirium tremens, the result of alcoholic stimulation, is an extremely common occurrence after all severe operations and injuries, and is one of the most serious causes of their mortality. Hence operations should never, if possible, be performed upon this class of persons so long as they can be put off, or without due preparation of the system; special care should also be taken to avoid shock and loss of blood, as these are two of the most predisposing causes of the disease.

It is well known that persons addicted to the immoderate use of opium and tobacco are liable to suffer from a peculiar form of nervous delirium after severe injuries and operations, characterized by excessive wakefulness, and a sense of indescribable wretchedness, with a bewildered and confused state of the mind, from which it is sometimes extremely difficult to rouse them, so as to induce them to take their necessary food and medicine. It is not improbable that the excessive use of coffee and tea may, in persons of a very nervous, excitable temperament, produce similar effects.

As was previously intimated, traumatic delirium usually sets in at an early period after the application of the external injury that provokes it; sometimes, however, the patient, perhaps contrary to expectation, goes on exceedingly well for some considerable time, happily surmounting the primary effects but suffering severely from the secondary, the consequence commonly of profuse, unhealthy, and exhausting suppuration. Again, instances occur in which he may have several attacks of this nervous suffering, with a variable interval of several days to several weeks, during which the mind may be perfectly clear and tranquil, the patient bearing up manfully under his disorders, sanguinely and fully anticipating none other than the most favorable termination.

Traumatic delirium, however induced, or in whatever manner it may present itself, is often extremely difficult of management. In its worst forms, the mind is frequently so completely disordered as to render confinement of the patients with the strait-waistcoat an indispensable element of the treatment. This is the more necessary when, as sometimes happens, the patient is disposed to tear off the dressings from his wounds, to commit suicide, or to hurt his attendants and nurses. There is a remarkable circumstance which has been noticed by all practitioners in this class of persons; I allude to their utter indifference to pain. So great is this, in many instances, that they will not only uncover their wounds, but absolutely take pleasure in handling and picking them. Dupuytren refers to the case of an old man who, having been operated upon for strangulated hernia, tore away the dressings from his groin, and composedly squeezed his bowels, his friends all the while thinking he was getting on most admirably, such was his calm and quiet demeanor as he lay in bed.

One of the most important indications, then, is to set a careful watch over the patient, in order that he may not do any harm either to himself or others; in wounds and fractures the most perfect quietude is generally necessary, and the greatest pains should, therefore, be taken to secure it to the fullest extent, for whatever has a tendency to disturb and fret the parts will be sure to act as a cause of additional excitement. Moral force alone will be of no avail; the patient can neither reason correctly himself, nor comprehend the arguments of those about him. Hence, if medicine does not promptly effect the object, the only resource is the strait jacket, applied of course with proper care, so that, while, on the one hand, it shall not be so loose as to frustrate the intention of its use, it shall not, on the other, be so tight as to occasion injurious constriction; a circumstance which, although a matter of paramount importance, is not always, as I well know from experience, so scrupulously attended to as it should be by nurses and practitioners.

The next indication is to tranquillize the nervous system, and induce sleep, or, in other words, to get rid of the redundant excitement. To fulfil this indication, anodynes must be administered in such doses as shall most promptly and effectually bring about the desired result. The patient must sleep before he can obtain relief; the early interposition, therefore, or suitable treatment is a matter of primary moment, attacking and routing

the disease, as it were, in its very incipiency, ere yet it has taken firm hold of the system. The most trustworthy and unexceptionable remedies are bromide of potassium and hydrate of chloral, in the proportion of twenty to thirty grains of the former to ten, fifteen, or twenty of the latter, repeated every two or three hours, until tranquil and refreshing sleep ensues. Of all the remedies that I have ever employed in the treatment of this class of cases, none have proved so speedily and permanently successful as these; and the great advantage which they possess over opium is that they do not cause nausea, constipation, headache, or, in short, any of the unpleasant effects which so often follow the exhibition of the latter article. There are, however, cases in which opium, either in the form of morphia or of the acetated tincture, in moderate and sustained doses, may be given with great advantage, especially if it be combined with tartar emetic. The latter remedy is particularly valuable when there is much vascular excitement, on account of its tendency to relax the system and promote perspiration. In the milder cases, the disease often promptly yields under the influence of a small quantity of laudanum, as from fifteen to twenty-five drops, in half an ounce of camphor-water and a drachm of compound tincture of cardamom, repeated every two or three hours. Dupuytren was in the habit of employing laudanum as an injection in this disease, giving from ten to twenty drops with a small quantity of water, and frequently repeating the dose, until he succeeded in accomplishing his purpose. The medicine thus administered often exerts, he declares, a much more prompt and happy effect than when taken by the mouth; and the result of my own experience amply corroborates the truth of the statement. As a preliminary measure, the rectum should be well cleared with an ordinary enema.

When opium and its preparations cannot be borne, an excellent substitute will occasionally be found in hyoscyamus, lupulin, aconite, belladonna, or Indian hemp; aided by the cool shower-bath, followed by dry frictions, or, what will generally answer quite as well, and be more convenient, sponging of the surface freely and repeatedly with tepid, cool, or cold water. When the delirium is furious, leeches should be applied to the temples, or a large blister to the nape of the neck, and cold to the scalp, previously divested of hair. As a temporary expedient, and as an auxiliary for allaying the violence of the spasms, the judicious inhalation of chloroform may be of service. General bleeding will not be proper in any case, whether of nervous delirium or delirium tremens, unless there is excessive plethora, with marked determination to the brain. In nervous, hysterical females, the free use of assafoetida and of valerianate of ammonia often produces a very happy effect.

When the patient has been an habitual drunkard, or when the delirium can be distinctly traced to the effects of the sudden withdrawal of alcoholic stimulation, the dictates of common sense, not less than the results of sound experience, indicate the propriety of a resumption of the accustomed drink, or a resort to an appropriate substitute. Much judgment will, of course, be necessary under such circumstances, lest the remedy be carried too far, causing thereby additional excitement and vigilance instead of composure and refreshing sleep. Nutritious food taken in small quantities, and frequently repeated, is generally very beneficial, the best articles being milk, beef essence, animal soup, and raw eggs beaten up with milk. When a mild stimulant is required there is hardly anything so reliable as a mixture of essence of brandy and catchup, or an infusion of capsicum. In most cases a good supply of nourishment is indispensably necessary to a cure. The bowels must not be neglected. A large dose of calomel, when there is much disorder of the secretions, given at the commencement of the disease, often excercises a powerful influence in quieting the nervous system and controlling morbid action. Vomiting, not unfrequently a prominent symptom, is most effectually relieved with the neutral mixture, champagne, and pounded ice. Sometimes a mustard emetic acts like a charm.

CHAPTER XIII.

GENERAL DIAGNOSIS.

DIAGNOSIS is the art of distinguishing and identifying diseases and accidents, or, in other words, of determining their seat, nature, and effects. Its study is of paramount importance to every practitioner, and he should, therefore, omit no opportunity of improving his knowledge of it. Its value, practically considered, has been felicitously expressed by Louis, the illustrious secretary of the French Academy of Surgery. "The science of diagnosis," says he, "holds the highest rank among the different branches of the healing art, as it is at once the most useful and the most difficult. The discernment of the peculiar character of each kind of disease and of its different species constitutes the source of all curative indications. Without a clear and exact diagnosis, theory must always be at fault, and practice frequently uncertain." It is by his knowledge of diagnosis that the practitioner acquires a command over disease which he who is destitute of it can never attain. It should, therefore, form the great object of his inquiry in every case of disease and accident; for to be able to locate and define their seat and character is almost to be able to cure them. To be incapable of doing this, is literally to grope in the dark; or to toss to and fro, like a mariner without a helm, upon an ocean of uncertainty. To disentangle truth from error; to give to disease " a local habitation and a name;" to distinguish one injury from another; and to base upon the knowledge thus derived a rational and scientific course of treatment, calculated to restore the sufferer to comfort and health, are among the highest attributes of the practitioner, and require an amount of talent, tact, and experience such as few men possess. " Know what ails the patient and he is already half cured," is a Chinese aphorism affirmable in almost every instance.

The very first thing that a surgeon should do when he is called to a case of disease is to set up an inquiry into its true nature; to ascertain where it is situated, or what structures it involves; how it has been brought about; what progress it has made; and what are its essential characteristics, or in what particulars it differs from other lesions. In order to do this with any tolerable degree of success, it is necessary, in many cases, literally to interrogate every important organ and tissue of the body, with a view of ascertaining which of them are more directly implicated in the disorder, which are free from suffering, and which are affected only sympathetically. Such a step is generally indispensable when the lesion is of spontaneous origin, or when it arises without any appreciable cause. When the converse is the case, a less elaborate examination will usually suffice to supply the requisite light. Not unfrequently the nature of the complaint is perceived at a glance.

SECT. I.—EXAMINATION OF THE PATIENT.

To examine a patient well, so as to elicit all the light that may be necessary to a thorough comprehension of the nature of his malady, requires generally great tact and an extensive knowledge of morbid and healthy anatomy, physiology, pathology, and animal chemistry, not to say anything of microscopy, now so much employed as a means of diagnosis. Any one may make a superficial investigation, and in the more ordinary cases such a mode of procedure may perhaps be all that is required; but under opposite circumstances, where everything is shrouded in obscurity, nothing short of the most patient and elaborate exploration will usually answer the purpose. Knowledge and tact alone, however, will not insure success; they may go very far, it is true, in enabling the practitioner to solve the mysteries of a case, but unless they are aided by a nice faculty of observation, and by a just sense of discrimination, he will never be able to analyze and group the facts presented to him in such a manner as to render them fully available when he comes to apply his therapeutic agents. Unfortunately, however, the power of observation is a rare gift, which few possess, and still fewer use to advantage. Surgeons, like physicians, have eyes, but they do not always see, and ears, but they do not always hear. Another

fault, of which, unfortunately, too many, even among the most sagacious and best informed, are frequently guilty, is the hasty manner in which examinations are made ; and, hence, it is no wonder that so many disgraceful and fatal blunders are daily committed by men who, if they would only allow themselves proper time, might see disease as clearly as if they were looking at it in a mirror. Hasty examinations commonly lead to hasty deductions, as hasty deductions do to hasty generalization and slovenly practice. All practitioners do not, of course, require the same amount of time to arrive at a correct judgment respecting the diagnosis of their cases ; some literally jump at conclusions ; others reach them only by a slow and tedious process of investigation and induction. Of the two, the latter are generally the safer practitioners.

The object of an examination is often seriously interfered with, if not entirely frustrated, by the want of coöperation of the patient, in consequence of his timidity, his want of intelligence, or the perverseness of his disposition. Much adroitness is, therefore, often required to bring out the desired result ; fully as much as the lawyer is obliged to expend in the examination of a witness who is incapable of appreciating the responsibility of his position, or of making a proper use of his knowledge. To gain the confidence of a patient is one of the first duties of a practitioner, as this is often necessary not only to a full development of the history of his case, but to its successful management. A gentle word, an agreeable tone, a winning manner, are well calculated to effect this result, and are, practically considered, attributes of the highest value. " To question fitly," says Rousseau, " is the art of a master." The examination should always be conducted with the greatest delicacy ; no unnecessary exposure should be made ; and great care should be taken to guard against fatigue, especially when the patient is exhausted by disease, shock, or loss of blood.

Age, occupation, climate, and habits of life, being so many circumstances calculated to modify morbid action, should be among the first objects of inquiry at the bedside of the sick. There are many diseases which occur only at particular periods of life. Thus, scrofula is most common in children, scirrhus in elderly persons, chronic enlargement of the prostate in advanced age. The influence of occupation in the production of disease is well shown in hemorrhoids, varix, and ulcers of the legs, and, to go no further, in necrosis of the lower jaw in persons engaged in the manufacture of lucifer matches. Gout, rheumatism, pneumonia, and pleurisy are most common in northern latitudes, while dysentery, hepatitis, and fever are most frequent in southern. Individuals of dissipated habits are particularly prone to erysipelas, boils, and carbuncles, and are often attacked with delirium tremens when they become the subjects of severe injuries, as lacerated wounds, fractures, and dislocations.

Particular inquiry should be made into the previous history of the case ; whether there is any hereditary predisposition to disease ; whether the suffering organ was ever similarly affected ; how the present attack came on, how long it has been in progress, and what have been its chief symptoms. A careful examination of this kind cannot fail to elicit important and valuable information, which, if properly applied, may go far in saving the patient's life, or in cutting short his disease.

A knowledge of the causes of diseases often throws valuable light upon their diagnosis. Thus, the knowledge that a youth affected with urethritis recently had connection with a lewd female, at once leads to a proper comprehension of the nature of the case ; and in the same manner important aid may be obtained in deciding between a specific and a non-specific ulcer on the head of the penis. The diagnosis of a malignant pustule upon the hand is generally determined at a glance by a surgeon of experience ; but one of an opposite character will hardly arrive at such a result without being told that the patient a few days previously was engaged in flaying a diseased ox, or in handling green hides. During the existence of endemic and epidemic diseases, all persons brought within their influence are liable to their attacks, and the similarity of their symptoms is consequently sufficient to stamp their character. The knowledge that pyemia frequently follows upon severe injuries and capital operations is of the greatest value to the practitioner, as it enables him at once to interpret correctly the symptoms which attend that peculiar affection, the nature of which was so long a mystery.

In accidents, a knowledge of the manner of their occurrence is often a matter of great moment in a diagnostic point of view. Thus, if a man, in the act of falling from a considerable height, has alighted upon the vertex, and is immediately rendered insensible, and particularly if he remains in that condition for a long time, the inference is strong that the base of the skull is fractured, and that he will perish from the effects of the lesion, although there may be no apparent injury upon the portion of the head which re-

ceived the blow.   In railway accidents the leg may be severely hurt, and yet not sufficiently so to account for the extraordinary depression of the system ; inquiry discloses the fact that the body was violently compressed between the car and a post, and a more thorough exploration leads to the discovery of a rupture of the spleen, liver, bowel, or bladder; a circumstance which at once establishes the diagnosis, and prevents the patient from being subjected to useless amputation.

When the patient is unconscious, whether from disease or accident, valuable information respecting the nature of the affection may often be obtained from his nurses and friends ; or, in the latter case, from the by-standers, who thus become important witnesses of what transpired at the moment in regard to the manner in which the injury was inflicted, the previous state of the intellect, and the condition of the person immediately consequent upon the receipt of the lesion.

In the more obscure cases of diseases and accidents, the diagnosis can be arrived at only after the most patient, thorough, and systematic examination, a random exploration being worse than useless.   Every organ must be questioned, and even then it will often be extremely difficult to determine what the lesion really is.   In my own examinations I usually begin with the alimentary canal, from which I pass, successively, to the abdominal and pelvic viscera, the lungs and their envelops, the heart, brain, and spinal cord, and, finally, the external surface, carefully noting everything of importance as I proceed.   In this manner, it is difficult for any serious disease to escape detection, if the practitioner is at all endowed with the faculty of correct observation.

EXAMINATION OF THE DIFFERENT ORGANS.

DIGESTIVE ORGANS.—Very useful diagnostic information is generally afforded by the state of the tongue in surgical affections.   In traumatic fever, abscesses, rheumatism, and gout, the organ is unnaturally dry, and covered with a thick, white fur, at the same time that its tip and edges are abnormally red.   A narrow, pointed, or accuminated appearance of the tongue is also frequently observed under these circumstances, especially in young subjects.   In profuse hemorrhages, the tongue is generally very pallid, soft, flabby, and indented at the edges.   A dry, brownish, and tremulous state of the organ, with difficulty of protrusion, is generally denotive of the existence of a typhoid condition of the system, and, in connection with other symptoms of exhaustion, is to be regarded as an unfavorable occurrence.   It is the kind of tongue which commonly attends gangrene, malignant erysipelas, and the latter stages of traumatic fever.

The appearances of the tongue sometimes afford useful hints respecting the state of the digestive apparatus, and even of the general system.   Thus, aphthæ upon this organ, or small ulcers scattered over its surface, are usually denotive of chronic gastric disorder, or derangement of the stomach and liver, by correcting which the disease promptly vanishes. In constitutional syphilis, the existence of mucous tubercles upon the tongue affords at once a satisfactory solution of the nature of the complaint.   The presence of an excavated ulcer upon this organ, or upon the tonsils, with a copper-colored border and a foul bottom, is generally equally diagnostic of a contaminated state of the system.

A thick and tumid upper lip is generally denotive of a scrofulous taint of the system, or of a vitiated state of the alimentary canal, depending upon the presence of worms, and disorder of the hepatic and follicular secretions.   A cracked, chapped, or fissured state of the lower lip is often an accompaniment of general plethora, overfeeding, and gastroenteric derangement.   A pale prolabium is indicative of a deficiency of the coloring matter of the blood, and of the necessity of tonics.

Useful information is sometimes derived from an examination of the gums.   A red, spongy, and tumid state of these structures is usually denotive of a scorbutic diathesis, especially if it be conjoined with frequent bleeding and hemorrhagic spots in different parts of the body.   An eroded appearance is indicative of an accumulation of tartar or of caries of the teeth, while the presence of sordes is expressive of a typhoid condition of the system.

Pain in the throat and difficulty of deglutition are evidences of tonsillitis, and of disease or mechanical obstruction of the œsophagus.   A careful inspection of the fauces and the introduction of the probang usually readily determine the precise locality of the affection, as well as its nature.   In the former case, the tongue is carefully depressed with the handle of a spoon, or a tongue-holder, the mouth being widely opened as the patient sits upon a chair in a strong light ; in the latter, the surgeon, standing behind the patient, whose head rests against his chest, carries the instrument gently and cautiously along the tube until it comes in contact with the obstruction, which is not passed all at once, or

forcibly, lest undue violence should be inflicted, perhaps eventuating in rupture, inflammation, or ulceration of the œsophagus.

No examination in any case of disease, if at all serious, whether surgical or medical, can be considered as complete without a thorough exploration of the condition of the stomach and bowels. When it is recollected that disorder of the secretions of these organs, the presence of irritating ingesta, or the accumulation of fecal matter, is frequently a source of disease in other parts of the body, as well as in these organs themselves, the importance of an attentive examination of them cannot be too much insisted upon. The insertion of the finger into the rectum, and the use of the speculum, often lead to the most useful knowledge of the condition of the anus and lower bowel. An examination of the alvine evacuations not unfrequently reveals important information in regard to the state of the liver, as the presence, absence, or quality of the bile, and the action of the mucous follicles of the alimentary tube, and should never be omitted in any case of serious disease or accident.

Intellect.—The intelligence is often remarkably altered in disease and accident. Delirium and incoherency are common effects of all lesions attended with high arterial excitement. Their character, degree, and duration vary much in different cases, and are greatly influenced by surrounding and intrinsic circumstances, as the nature of our treatment, the intensity of the morbid action, the importance of the affected organ, and probably also by the idiosyncrasy of the individual. In general, as they are of a purely sympathetic character, they rapidly disappear with the excitement that induced them; coming and going, perhaps, several times in the twenty-four hours, especially during the vesperal and nocturnal exacerbations which are so liable to distinguish most febrile attacks, whether traumatic or idiopathic.

In organic disease of the brain and its envelops, on the contrary, a different order of things usually occurs. Here the delirium, once fairly begun, continues uninterruptedly, although it may be characterized by intervals of remission; and, as the morbid action progresses, it generally lapses into stupor, and this, ere long, into deep coma, which is but too often the immediate forerunner of dissolution. In compression of the brain, whether from extravasated blood, excessive congestion of the cerebral vessels, effusion of serum, or depression of the cranial bones, the intelligence is commonly completely abolished; the patient is deprived of all sensation and volition, and cannot be roused by the most powerful stimulants. He is, in fact, a mere automaton, dead to all surrounding impressions. If, from any cause, inflammation of the brain or of its membranes arise, the face soon becomes flushed, the eye suffused, the pupil contracted and impatient of light, the skin hot and dry, and the pulse quick, hard, and frequent. Delirium soon sets in; the mind becomes incoherent, and, although questions may still with some effort be answered rationally, yet the patient speedily lapses into his former condition, knitting his brows, tossing from side to side, withdrawing his hand from the attendant, muttering constantly, and falling gradually into a more unconscious state. Rigors generally occur early in the disease, and are always denotive of great danger. If effusion of serum, lymph, or pus take place to any considerable extent, convulsions and deep coma are sure to follow, soon terminating in death.

Countenance.—The state of the countenance is always a subject of inquiry with the intelligent practitioner. The mirror of the soul, it reflects, to a greater or less extent, alike the sensations of pleasure and of pain, of joy and of sorrow, and is thus capable of supplying important diagnostic indications in a great variety of diseases and accidents. To call attention to all the details which necessarily connect themselves with the study of the physiognomy under these circumstances, would be out of place in such a work as this, and I shall, therefore, content myself by referring to a few of the more frequent and conspicuous.

Excessive pallor of the countenance, especially of the prolabia, is generally denotive of great loss of blood, or of extreme shock of the nervous system. In the latter case it is often associated with a peculiar withered and shrunken expression of the features, reminding one sensibly of the decay of a leaf in autumn. In apoplectic affections of the brain, the face is turgid, flushed, and paralyzed on one side, thus causing serious distortion, the angle of the mouth being drawn to the opposite side, while the eyelid on the affected side has a drooping appearance, descending hardly half-way over the ball. In general inflammatory fever, whether the result of accident or of internal causes, the countenance is red and tumid, the eye is suffused, and the ala of the nose is rapidly dilated and contracted by the hurried inspiration. When the breathing is much embarrassed, as when there is deep congestion of the lungs, or mechanical obstruction to the entrance of the air, as

when a foreign body exists in the larynx or trachea, the face is livid and often remarkably puffy, particularly when the affection is of long standing, and accompanied by œdema of the subcutaneous connective tissue.   All painful affections of these organs are characterized by an anxious expression of the features, attended by an unusual dilatation of the nostrils during each act of inspiration, and by a peculiar heaving movement of the chest.   " In inflammation of the abdominal viscera," observes Dr. Marshall Hall, "attended with severe pain, the muscles of the face are in a state of continued contraction ; the features are unnaturally acute, the forehead is wrinkled, and the brows knit.   The nostrils are acute and drawn up ; the wrinkles, which pass from them obliquely downwards, are deeply marked ; the upper lip is drawn upwards, and the under one frequently downwards, so as to expose the teeth.   The state of the features is aggravated on any increase of the pain from change of position or external pressure.   When the abdominal pain arises from spasm, the muscles of the face are exceedingly contracted and distorted during the paroxysms of pain ; but in the intervals of the paroxysms the countenance assumes a calm and placid aspect."

The diagnostic value of the Hippocratic countenance has long been recognized by practitioners.   Its presence is always denotive of extreme danger, and is commonly associated with other symptoms of an untoward import, as twitching of the tendons, high delirium, a dry tongue, sordes on the teeth and gums, and excessive prostration.   It consists in a peculiarly sharp, retracted, and withered appearance of the features, and generally attends the closing scenes of all typhoid states of the system, whatever may be their cause or character.

Respiratory Organs.—The state of the voice often furnishes useful information respecting the nature of the lesions of the larynx and trachea.   Its peculiarity in croup is well known, being either sharp and shrill, like the crowing of a young cock, or low, hoarse, and almost extinct, especially if the disease has made considerable progress.   In œdema of the glottis, without being always hoarse, it is generally reduced to a mere whisper ; and in thickening of the vocal cords and ulceration of the mucous membrane of the larynx, partial loss of voice, and ultimately complete aphonia, generally attend.

The respiration should always be attentively examined.   In all acute diseases, attended with unusual vascular excitement, it is increased in frequency, short, and laborious.   In pneumonia and pleurisy it is generally diaphragmatic, the intercostal muscles being almost completely quiescent, with hardly any perceptible elevation and depression of the ribs. The patient, alarmed and anxious, breathes with great difficulty, dilating his nostrils at every inspiration, and raising the shoulders and upper part of the chest, so as to draw in as much air as possible at each effort.   In inflammation of the abdominal viscera, on the contrary, the diaphragm is nearly stationary, while the intercostal muscles are in full play, the act of inspiration being short and panting, lest the descent of the diaphragm should produce an aggravation of suffering by rudely compressing the affected organs.   In affections attended with cerebral congestion, effusion of blood, or depression of the skull, the breathing is slow, labored, and irregular ; often stertorous, and accompanied by a peculiar whiff.   In spasmodic diseases of the respiratory organs, the inspiration is quick and imperfect, as if the patient was unable to dilate the chest, and is usually accompanied with a characteristic wheezing sound, often audible at a considerable distance, during expiration, which is, at the same time, labored, and protracted.   Short, difficult, and anxious breathing, aggravated by muscular exertion, as in ascending a hill, or rapid talking, is generally denotive of hydrothorax, of solidification of the lungs, or of organic disease of the heart and great vessels.

Heart and Pulse.—The diagnostic signs manifested by the heart and arteries deserve careful consideration.   In examining the pulse, the exponent of the great central organ of the circulation, particular attention should be paid to its frequency, volume, and force, as these constitute the leading features by which the practitioner judges of the state of the system ; or, in other words, of the character and effects of the morbid action.   To do this properly requires not a little knowledge and experience, for nothing varies more than the condition of the pulse in health and disease.   Hence it is not surprising that it should have been pronounced by one of the ancient physicians to be the most fallacious of symptoms.

In traumatic fever the pulse, as a general rule, is quick, frequent, and hard, and similar qualities usually characterize it in idiopathic affections.   The increase in the number of its beats ranges from ten to thirty and even forty in the minute ; they are performed with a peculiar sharpness and rapidity, and the blood is sent into the arteries with such momentum as to cause their coats to rebound under the finger, offering thus a decided resistance to its pressure.   When this is the case, the pulse is said to be hard.   Hardness, quickness,

and frequency are often associated with fulness, especially in very plethoric subjects, laboring under intense inflammatory excitement; but such a coincidence is by no means always necessarily present; on the contrary, instances occur where the pulse is so exceedingly small and thready as to require some care to detect it. This is generally the character of the pulse in peritonitis, from whatever cause arising, and, therefore, it affords valuable diagnostic information. In certain affections of the brain, as in compression, whether a result of apoplexy or external injury, the pulse is slow, full, and laboring, as if the heart were oppressed by a heavy load which it is found difficult to carry or to shake off. The pulse after hemorrhage is strikingly peculiar, although it is not easy to define its character; it may be described as being very sharp, quick, and thrilling, as if the blood were sent into the artery with a kind of jerk, imparting thus a vibratory sensation to the finger. Once felt, it is impossible ever to forget it. An intermittent pulse is generally denotive of organic disease of the brain, or of the heart, lungs, or great vessels; sometimes, however, it appears to be the result altogether of functional disease, as dyspepsia, or gastro-intestinal irritation.

In examining the pulse with a view to its diagnostic value, it is to be remembered that it may be naturally slow or frequent, hard or soft, full or small, strong or feeble, depending upon idiosyncrasy, or the effects of previous or existing disease.

The time and mode of examining the pulse require some attention. As a general rule, the surgeon should not put his hand upon the wrist immediately after he has sat down by the side of the bed, as such a course would be likely to cause alarm, and thus lead to erroneous inferences. Nor should he use a watch for the purpose of counting it, especially if the patient is very sick and nervous, as this also might excite injurious apprehension. In fact, it is impossible to conduct the examination too carefully; for, unless this be done, the intention of the practitioner will often be completely thwarted, simply in consequence of his awkwardness. At least two fingers should be placed upon the radial artery, and the application should be continued sufficiently long to enable him to determine fully the character of its beats, particularly their frequency, volume, and power of resistance.

Kidneys.—The renal secretion should claim particular attention in every severe case of accident and disease. A very superficial inspection will generally at once detect remarkable deviations from the normal standard, both as it respects the color, quantity and consistence of this fluid, as well as any tendency it may manifest to the formation of deposits after having stood for some time in the receiver. But if a more thorough investigation be deemed necessary, as when organic disease of the kidney is suspected, or with a view to the detection of the existence of any particular calculous diathesis, a more minute and elaborate examination, conducted with the microscope and chemical tests, will be required; and it need hardly be added that such a procedure generally calls for an amount of knowledge, skill, and experience such as few professional men possess. As this subject will receive special consideration in the chapter on the urine and its deposits, no further allusion to it need here be made.

Finally the practitioner must not neglect to examine the state of the skin, noting particularly the character of its temperature, the presence or absence of moisture, the degree of its contractility, and any change of color it may have experienced; the condition of the limbs, as to the existence or non-existence of paralysis or injury; and, lastly, the state of the genital organs, if, upon inquiry, there is reason to suppose that they are either the seat of the morbid action, or that they deeply sympathize in the disorder of other parts of the body.

SECT. II.—MENSURATION.

An examination of the dimensions of a part occasionally affords valuable aid in determining the diagnosis of its lesions. Such a mode of investigation is particularly serviceable in fractures and dislocations, in coxalgia, and in affections of the chest, especially in pleuritic effusions, so common after accidents and disease.

The best contrivance for ascertaining the amount of shortening in an injured or diseased limb is the graduated tape, used by seamstresses and tailors, and inclosed in a metallic case, so as to admit of its being carried in the pocket. It is a yard in length, by half an inch in width, and being composed of oil-cloth it is perfectly inextensible, thus rendering it admirably adapted to the object. In order to attain perfect accuracy of result, it is necessary that the sound and affected members should be placed as nearly as possible parallel with each other; for if there is the slightest variation in their inclination it must proportionately impair the value of the examination, if not completely destroy it. Thus, for example, in trying to ascertain the amount of overlapping of the fragments of a broken

femur, the two thighs should be placed not only parallel with each other, but great care should be taken that they, as well as the buttocks, rest evenly upon the bed, table, or floor on which the patient lies. Finally, in order to perform the operation in the most unexceptionable manner, the additional precaution should be taken of maintaining the head, chest, pelvis, and extremities all in a straight line until the measurement is completed.

After the limbs and body have been adjusted as here described, two fixed points are selected, between which the tape is stretched. Thus, to take the thigh again as an illustration, the two proper points are the anterior superior spinous process of the ilium and the inner border of the patella. The distance between these two prominences having been ascertained upon the affected member, the tape is next stretched between the same points on the sound limb, the difference in the length between the two being the sum of the shortening of the injured bone. When no fixed points can be obtained, a mark may be made upon the skin, either with ink, iodine, or nitrate of silver. In trying to ascertain the precise amount of shortening in fractures of the extremities, especially the lower, we must not overlook the important fact, that there is in many cases, naturally, a marked difference in the length of the limbs, the disparity varying from a few lines to half an inch or even an inch.

The graduated tape may also be employed for measuring the diameter of a limb, as in disease of an important joint, or a suspected morbid growth. Or, instead of this, recourse may be had to the graduated compass of Mayor, which, however, notwithstanding its ingenious mechanism, really possesses no positive advantages over the tape. This instrument consists of four pieces, the central one, which is a flat rod, being marked by a scale of inches and lines.

Mensuration of the chest is often practised in pleuritic effusions, although such a means of diagnosis is seldom necessary in the hands of an intelligent and skilful surgeon, auscultation, percussion, and inspection being quite sufficient for the purpose in almost every instance that may come under his observation. When more than ordinary care is desired, the graduated tape, extending from the middle of the sternum to the centre of the spine, will readily supply the requisite information.

The plumb-line is occasionally used for determining the existence of curvature of the spine; such an expedient, however, can only be necessary in the earlier stages of the malady, before marked deformity has set in. When the disease is fully established, such a mode of investigation would savor alike of affectation and stupidity.

A ready method of determining the angle of on object, as, for example, that of a broken bone, has been suggested by Malgaigne. It consists in applying a sheet of paper, by its edge, to the limb so as to represent its vertical axis. At the point where the axis changes its direction, the paper is so folded as to follow it exactly; the result will be that the salient angle thus found will necessarily give the entering one caused by the fragments of the deformed bone. In order to determine the degree of this angle, a sheet of paper is folded in four, which " makes a right angle, or $90°$; folding again, one of the sides affords an angle of $45°$; adding this angle of $45°$ to the unchanged right angle, gives an angle of $135°$, and so on. Applying now this extemporaneous quadrant to the already ascertained angle of the fracture, we obtain without trouble, or loss of time, as accurate an estimate as possible."

SECT. III.—ATTITUDE OF THE PATIENT.

The attitude of the patient and the position of the affected part are variously and often remarkably changed in disease and accidents, and afford, in many cases, valuable diagnostic indications, not attainable in any other way. The study of the variations in the configuration of the body is of much greater moment, as a means of distinguishing different lesions, than is generally imagined, and has received less attention than its importance merits. In some affections, the diagnosis absolutely hinges mainly, if not entirely, upon the attitude assumed by the patient in consequence of the morbid action. We need only instance the peculiar distortion of the body in tetanus, caused by the continued and violent contraction of the muscles, drawing the trunk, in one case, powerfully forwards, in another backwards, and in a third to one side. No one that has ever witnessed this change of configuration can possibly mistake it in a similar attack; for there is no other lesion capable of producing it. In caries of the vertebræ, usually known as Pott's disease, and in lateral curvature of the spine, the result of irregular muscular action, the distortion of the body is characteristic. In coxalgia, the flattening of the hip, the elevation of the

pelvis of the affected side, the retraction of the heel, and the effacement of the femoro-gluteal crease are among the most valuable diagnostic signs of the malady.

In disease and injuries of the chest, the position of the patient is often highly characteristic. In inflammation of the lungs and pleura, attended with slight effusion, he generally lies on the affected side, or else upon his back, not on the sound side, as the weight and pressure of the diseased organ would seriously impede respiration and excite violent coughing. In hydrothorax, with large accumulations on both sides, the patient is obliged to raise his head and shoulders very much, or even to sit up in bed, in order to obtain the requisite supply of air. When he lies down, the effused fluid is diffused over a larger portion of lung, an occurrence which is instantly followed by increased difficulty of breathing, and by the necessity of a change of posture to prevent impending suffocation. "When out of bed, he is often observed to sit with the arms placed along the side, and the hands fixed and pressing forcibly on the chair or sofa on which he rests; in other cases he leans a little backwards, still supported by the arms and hands, which are pressed behind his back."

The attitude assumed by the patient in inflammation of the abdominal and pelvic viscera is generally very striking and characteristic. Unable to shift his position, he lies constantly upon his back, with his head and shoulders considerably elevated, the knees raised, and the thighs partially flexed, the object being to relax the abdominal muscles in the greatest possible degree, so as to take off their weight and pressure from the inflamed surface. In spasmodic affections, on the contrary, the position of the patient is altogether different; instead of observing dorsal decubitus, he lies at one time on this side and then on the other, now on the back, and next on the belly; and instead of avoiding pressure, he actually courts it, not feeling comfortable without it. Hence, he often doubles himself up, and twists and contorts his body in almost every possible manner, in order to obtain relief.

In stone of the bladder impeding the flow of urine, the attitude of the patient is frequently very singular. Sometimes he is compelled to assume a stooping posture; at other times he crosses or separates his legs, inclines his body to one side, lies down, rests on his elbows and knees, or lies on his back, and throws up his buttocks. In traumatic and other affections, attended with typhomania, retention of urine may be suspected if the patient lies on his back, with the limbs retracted. In acute inflammation of the kidney, the body is generally inclined a little forwards and towards the affected side, so as to relax the lumbar muscles, and take off any pressure they might otherwise exert upon the diseased organ.

The nature of an accident is not unfrequently revealed by the attitude of the part and body; sometimes by the one, sometimes by the other, and occasionally by both. Thus, the manner in which the patient inclines his head and supports his arm in fracture of the clavicle is so peculiar as to be absolutely, in great degree, pathognomonic of the nature of the lesion. Dislocations of the shoulder, hip, and other joints are denoted by striking, if not characteristic, changes in the attitude of the body and limb. The existence of a fracture is often revealed by a peculiar change in the conformation of the affected member, consisting either in a marked shortening, or in a peculiar alteration in the axis of the part. The disease called wryneck derives its name from the peculiar twist of the neck by which it is distinguished.

SECT. IV.—EXTERNAL CHARACTERS.

Important diagnostic data are sometimes furnished by the color, form, consistence mobility, pulsation, temperature, crepitation, sensibility, or odor of a part, and by the spots, scars, or ulcers upon its surface. A mere glance at these different topics will serve to show their value as means of distinguishing morbid action, whether it be considered simply in reference to its nature, or its nature and degree.

Thus, as stated under the head of inflammation, the *color* of the diseased part may be scarlet, as in inflammation of the mucous membrane of the fauces; lilac, as in sclerotitis; grayish or brick-colored, as in iritis. When the redness occurs in the form of a streak, extending up the arm or leg, it is denotive of phlebitis, or of angeioleucitis. Diffused discoloration characterizes erysipelas; circumscribed discoloration, boils and carbuncles. A scarlet hue implies great vascular activity, such as exists in acute inflammation; a purple hue, on the contrary, denotes partial stasis of the blood, which, if not soon arrested, may lead to gangrene.

Change in the *form* of a part may be caused by swelling, as in inflammation attended

with effusion, or it may depend upon the presence of a new growth, or it may be the result simply of hypertrophy. In fractures it is caused by displacement of the ends of the fragments; in dislocations, by the presence of the head of the bone in its new situation. In hernia, very striking changes generally attend the figure of the affected parts, especially when the protrusion is old and unusually bulky.

Extraordinary *consistence* of a part is indicative either of excessive induration from inflammatory deposits, particularly semiorganized lymph, or of the presence of a solid tumor, or a displaced bone. When the part is unusually soft, the alteration of consistence may depend upon the presence of pus, fluid blood, serum, or serum and lymph, and often requires the closest scrutiny for the successful detection of its precise character. Under such circumstances the history of the case frequently affords important diagnostic data, especially the age of the accumulation, and the presence or absence of inflammatory symptoms. If the part fluctuates distinctly, and is, withal, red, tender, or painful, the probability is that the alteration of consistence is due to the existence of pus; if, on the other hand, it is perfectly free from discoloration and uneasiness, although the undulation under pressure may be most perfect, the conclusion must be that the disease is either a chronic abscess, or else some serous or hematoid cyst.

The *mobility* of a part may be diminished or increased, thus throwing important light upon the nature of the case. As a general rule, it may be stated that it is lessened in dislocations, and augmented in fractures. The value of this symptom is well shown in diseases of the articulations, as well as in inflammation of other parts of the body, which, if at all seriously involved, have their mobility always proportionately diminished. In malignant tumors, loss of mobility of the morbid growth generally forms a prominent phenomenon in the advanced stage of the disease, in consequence of the firm adhesions that take place between it and the surrounding structures. A similar effect may be produced by the manner in which such tumors are bound down by the aponeuroses and muscles. In affections of the eye an alteration of the mobility of the iris often affords most important diagnostic information.

Abnormal *pulsation* in a part leads to the suspicion of the existence of aneurism, a suspicion almost converted into certainty, if, in addition to this phenomenon, there is a peculiar thrill, with a vibratory sensation, and a decided diminution of the volume of the part upon the application of pressure on the cardiac side of the artery supplying it with blood. The mere fact of the existence of abnormal pulsation should put the surgeon upon his guard, in order that, by redoubling his efforts at a thorough exploration, he may not commit any errors of diagnosis; laying open, perhaps, an aneurism, when he supposes that he is only dealing with an abscess or a hygroma.

The surgeon occasionally meets with what is denominated *crepitation*, a rough, grating, or friction sound, of great value as a diagnostic in fractures, emphysema, and inflammation of the sheaths of the tendons. In many cases it may be both felt and heard. In fractures it is produced by rubbing together the ends of the broken bone, and is generally so distinct as to be completely characteristic of the nature of the lesion. In order to elicit it, a good deal of management is often necessary; but in general it will be sufficient, after the ends of the broken bone have been fairly placed in contact, to grasp one piece firmly, and to hold it so while the other is rotated on its axis; or both fragments may be moved simultaneously in opposite directions.

The crepitation of emphysema is a kind of crackling sound, similar to what is produced by the rumbling of dry parchment, or by rubbing together numerous little dry, friable balls filled with air. The part, moreover, feels soft and puffy, and the contained air may be easily pressed from one spot to another.

Bony tumors of the antrum of Highmore and of the lower jaw, attended with great expansion and attenuation of their walls, occasionally emit, when pressed between the fingers, a peculiar crackling noise, similar to that of dry parchment. The sound thus elicited, however, is altogether different from crepitation, properly so termed, and its chief value consists in showing the alteration which the osseous tissue is capable of undergoing when it is subjected to long-continued, eccentric pressure.

The crepitation attendant upon inflammation of the sheaths of the tendons is altogether different from the two preceding varieties, resembling the sound caused by rubbing dry starch between the fingers. When the disease is chronic, it may sometimes be both heard and felt. It evidently depends upon the presence of plastic matter, and is most common about the wrist and ankle. This sound is often closely imitated in affections of the mucous burses, especially when they are considerably distended with fluid, intermixed with flakes of lymph and fibrinous concretions.

A faint crepitating sound is sometimes produced by breaking up the clots of a sanguineous cyst, and rubbing the fragments between the fingers. The noise, if any occur, is always most distinct at the base of the tumor, where most of the solid matter is necessarily collected.

An alteration of *temperature* in parts affected with disease is sufficiently common. and occasionally affords valuable diagnostic intimations. With what interest does not the surgeon watch the rise of heat in a limb after the ligation of its principal artery! A casual examination is generally sufficient for its detection; when more than ordinary nicety is required, recourse may be had to the thermometer. The intensity of the morbid action may sometimes be pretty accurately measured merely by observing the increase of its temperature. A sudden diminution of temperature, in a part previously in a high state of inflammation, may generally be regarded as an omen of unfavorable import, as it is denotive of the approach of gangrene.

An increase of the *sensibility* of a part is a frequent, if not an almost constant occurrence in disease, especially when acute. In ophthalmia, the slightest ray of light is a source of distress to the patient; in otitis, the ear is intolerant of sound; and in gastritis the stomach is oppressed by the smallest quantity of fluid, however bland, or however cautiously used. Parts, such as bones and ligaments, that are perfectly devoid of feeling in health, often become exquisitely sensitive in inflammation; and thus it is that the practitioner is not unfrequently enabled to detect the existence of morbid action in structures hidden from view, much better than he can in any other manner. The proper way of ascertaining the existence and amount of morbid sensibility is to make gentle and methodical compression, or to percuss the affected part, so as to communicate to it the vibrations of the whole hand, or, what is preferable, of one of the fingers.

When pain exists, a careful distinction should be drawn between that which arises from inflammation and that produced by spasm and neuralgia. In inflammation, the pain is steady and persistent, increased by motion and pressure, commencing with the morbid action, keeping regular pace with it, and gradually disappearing as the morbid action declines. In spasmodic affections, or colic, on the contrary, the pain is paroxysmal, or marked by distinct intermissions; abrupt, both in its invasion and departure; relieved by pressure, and change of posture, and generally attended with flatulence of the stomach and bowels. In neuralgia, the pain occurs in transient and violent paroxysms, darts along the course of the affected nerves with the rapidity of lightning, and is usually accompanied by more or less tenderness of the part, without any distinct tumefaction, discoloration, or augmentation of temperature.

Finally, there are certain affections which may sometimes be readily diagnosticated by a careful examination of the *cutaneous* surface, and that of the mucous outlets. Thus, if there are copper-colored eruptions upon the skin, excavated ulcers on the fauces, or tubercles upon the tongue, cheek, or lip, no one could fail to conclude that the system is laboring under a syphilitic taint. Partial or complete destruction of the uvula, tonsils, or arches of the palate, would inevitably lead to a similar inference, especially if, added to this, there is evidence of actual disease. Scars upon the cutaneous surface, scattered irregularly about, large, deep, white, and permanent, are generally denotive of the former existence of rupia.

The character of the ulcer will occasionally lead to the detection of its cause, or to the state of the system which has induced it. A girl, aged fourteen, was brought to the Clinic at the Jefferson Medical College, on account of a large chronic ulcer, of nearly one year's duration, seated in front of the leg, directly over the tibia; it was excessively painful, and had resisted a great variety of local and constitutional remedies. Having placed her under the influence of chloroform, I scraped away a thick mass of semi-organized substance which formed the bottom of the ulcer together with the carious and softened portion of the bone; and when she returned, a week afterwards, I was struck with the remarkable improvement that had taken place both in the part and system. Shortly after her visit, however, not less than five or six small unhealthy-looking ulcers, with thick, everted edges, and a foul, ugly surface, broke out around the old one, which by this time had also changed for the worse. Convinced that the disease was of a syphilitic nature, the patient was placed, without any further inquiry into the history of the case, upon the use of iodide of potassium and bichloride of mercury, under the influence of which, and of a nourishing diet, she rapidly regained her health and strength, with good sound cicatrices.

Absence of contractility in the *muscles*, whether dependent upon organic changes of their fibres, or upon loss of nerve power, is often very readily determined by electricity,

which thus becomes a most valuable means of diagnosis. In paralysis of the extremities, for example, if contraction be promptly provoked on the application of the electric current, it is evident that the integrity of the nervous connection of the limb with the spinal cord must be perfect, and also that the portion of the cord through which this connection is established is in a sound state, and conversely. The cause of the paralysis must be seated either higher up in the cord, in the brain, or in the muscular tissue, altered by disease, as the fatty or fibroid degeneration. In case of injury, as a bruise or wound, a similar test will determine the seat of the affection.

SECT. V.—THERMOMETRY.

Thermometry, as a means of diagnosis, is extensively practised in all cases of fever, whether traumatic, idiopathic, or specific ; its object, as the name implies, being to ascertain the amount of heat developed in the system during the progress of disease, and thereby determine the degree of the morbid action present in any given instance. The knowledge derivable from such an examination is not less valuable than the information obtainable from an examination of the pulse and of the respiration.

The normal average temperature of the body in the axilla, in the milder regions of the world, is about $98\frac{1}{2}°$ Fahr., from which it seldom deviates in health more than $1.8°$ to $3.6°$. Besides, any such departures are always very transient, whereas those occasioned by disease invariably continue so long as the morbid action exists. The temperature is heightened by exercise, reduced by sustained mental labor, and influenced by food, stimulants, age, temperament, habit, occupation, climate, the condition of the atmosphere, and other causes. It is liable to fluctuate during the twenty-four hours, and is usually at its maximum in the morning. The pulse and temperature in health usually rise synchronously, and every degree above $98°$ corresponds with an increase of ten beats of the pulse in the minute. Any persistent rise of the mercury above $99.5°$, or depression below $97.3°$ Fahr., is an indication of disease.

Unnatural heat cannot exist without fever, any more than fever can exist without abnormal heat. They are dependent the one upon the other. A patient may have a severe rigor, shiver, or feel icy cold, and yet the inner parts be inordinately warm, so that he may literally, as far as his sensations are concerned, burn and freeze at the same moment.

In pyemia the temperature is often very high, ranging from $106°$ to $108°$. There is, however, nothing very definite in this respect ; for observation has shown that, while in some cases and under certain circumstances, it is normal or nearly so, in others it presents remarkable variations, a sudden rise being often followed by a sudden decrease, and conversely. A temperature of $101°$ to $103°$ shows a mild disease, and one of $105°$ a grave one. In fever it ranges from $100°$ to $106°$. In low forms of this malady the hands and feet may feel cool, and yet the thermometer in the axilla may rise to $104°$. In acute rheumatism a temperature above $104°$ is always an alarming symptom ; and a similar remark is applicable to pneumonia. A rise of heat from $106°$ to $108°$, $109°$, or $110°$, is generally an indication of rapidly approaching dissolution. The highest rise of the thermometer before death has been noticed in tetanus and scarlatina. A persistence even of an inconsiderable degree of abnormal heat is an evidence of incomplete recovery ; and a recurrence of a high temperature during convalescence is a certain sign of an approaching relapse.

Fig. 119.   Fig. 120.

Thermometer.   Surface Thermometer.

Decrease of temperature is of great assistance in determining the prognosis of grave injuries and operations, a fall of one degree below the normal standard indicating depression, a fall of two degrees being an evidence of collapse, and a fall of from three to five degrees indicating algid collapse.

The thermometer usually employed for measuring the temperature in disease is the

one depicted in fig. 119. It is a very delicate, sensitive instrument, with a range of scale from 90° to 115°, and a subdivision of each degree into fifths. It may be furnished with a curved bulb for the sake of greater convenience in its application to the axilla, the situation generally selected for the purpose, as calculated to insure greater accuracy. The patient must have been in bed, well covered about the chest and shoulders, for at least one hour before the experiment is made. The instrument, previously a little warmed, is retained in the axilla, from which the perspiration has been wiped away, for ten minutes, at the end of which the rise or fall of the mercury must be carefully noted and recorded. The observations should be taken regularly every day twice, as nearly as possible at the same hour, either by the attendant himself, or by a trustworthy assistant, throughout the entire period of the sickness, the best time being between seven and nine o'clock in the morning, and between five and seven o'clock in the evening. The frequency of the pulse and of the respiration should be noted at the same time. In chronic cases, attended with occasional exacerbation, and also in acute attacks after the temperature has regained the normal standard, one daily observation made in the afternoon will be sufficient.

Important information in regard to deeply seated abscesses and rapidly growing tumors, particularly the small-celled sarcomas, may be derived from the use of the surface thermometer depicted in fig. 120. The temperature should first be taken over the seat of the disease, and then be compared with the temperature of the corresponding point of the opposite side of the body, the increase denoting the activity of the morbid action.

SECT. VI.—INSTRUMENTAL EXPLORATIONS.

There are certain affections the character of which can only be ascertained by a careful examination with the aid of instruments, full access to them in any other manner being impracticable. The instruments mainly required for this purpose are the probe, bougie, sound, speculum, stethoscope, and exploring needle, each of which will, therefore, demand some notice.

Probe.—The probe, fig. 121, is chiefly employed for the purpose of exploring fistulous tracks and sinuses, the course of balls, and the presence of foreign bodies. It may, therefore, be considered as a highly valuable instrument, one which is daily and hourly

Fig. 121.
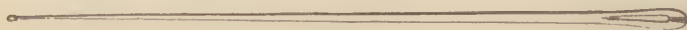
brought into requisition by the surgeon in extensive practice. It is generally made so as to be flexible, being composed of silver or other suitable metal; and varies in length, diameter, and shape according to circumstances. The ordinary pocket probe is about five inches in length, and of the diameter of a crow-quill, one extremity being blunt, the other somewhat pointed, or furnished with an eye. For exploring the lachrymal passages a much more delicate instrument is required; the uterine probe, on the contrary, is very large; a long and rather stout instrument is generally employed for ascertaining the existence of a foreign body in the air-passages after the trachea has been opened, for tracing the course of a ball, and for exploring certain varieties of fistules and sinuses.

For detecting the presence of deep-seated balls, a probe, tipped with porcelain, has been advantageously used, as in the celebrated case of Garibaldi; and Mr. L'Estrange, of Dublin, many years ago invented what may be called a reverberating probe, an instrument provided with a little drum, consisting of a small circle of light wood, mounted on a stem which, secured to an ordinary probe, or sound, conveys to the ear, as well as to the finger, a more perfect idea of the nature of the material touched, whether muscle, bone, cloth, calculus, or metal, than any other contrivance.

Dr. L. A. Sayre, in 1871, devised what is now known as the vertebrated probe, fig. 122, consisting of a series of hollow silver disks, connected by a linked longitudinal chain, terminating in a square rod. The contrivance is particularly serviceable in the exploration of sinuous ulcers, in diseased joints, in flexions of the uterus, and in gunshot wounds, the small end of the instrument being, in the latter case, tipped with porcelain.

The *index finger*, if sufficiently long, and not too thick, is the best probe of all, as the information furnished by it is generally much more reliable than that supplied by a metallic instrument. It is particularly available in the examination of the vagina, uterus,

and rectum, whether the object be to detect the presence of disease, malposition, or the existence of an extraneous body.

The *rectal touch*, performed with the index finger, is constantly practised by the surgeon in sounding patients for stone in the bladder, with a view not only of ascertaining the presence of the foreign substance, but also of determining its size and situation. Enlargement of the prostate gland, and the existence of calculi in its substance, can seldom be satisfactorily diagnosticated in any other manner. Displacements of the uterus, pelvic tumors, and malformations of the internal genital organs, are often promptly detected by the rectal touch; and there is no practitioner that does not employ the finger in suspected disease of the anus and lower bowel. The rectal touch can readily discriminate between a hemorrhoidal tumor and a carcinomatous growth, a polyp, a prolapse of the mucous membrane, or a foreign body. The extent of the spasmodic contraction of the anus, which attends fissure of that outlet, is generally readily ascertained by the insertion of the finger.

The *vaginal touch* affords important information in relation to the diseases of the vagina and the uterus. It is in this manner that the practitioner ascertains the existence of the various kinds of tumors that are liable to form in these organs, whether benign or malignant, and also the different displacements to which they are subject. A practised finger will readily detect a carcinomatous ulcer of the uterus, a rent in the vagina, and a calculus in the bladder.

Whatever may be the instrument employed, it should be well oiled and warmed, to facilitate its introduction, and passed along in as gentle and easy a manner as possible. If the structures are inflamed and tender, it may be necessary, as a preliminary step, to lessen the sensibility by soothing measures, otherwise the procedure may be productive not only of severe pain, but of an aggravation of the disease. No general rules can be laid down respecting the position of the part or of the body during the examination, although it must be sufficiently obvious that this is a matter of paramount importance to a satisfactory result. In exploring fistulous tracks it is occasionally necessary to enlarge their orifice somewhat, in order to afford a more ready passage to the instrument or finger.

Bougie.—For ascertaining the condition of the mucous outlets of the body, as the urethra, œsophagus, and rectum, a bougie, which is but another name for a probe, is generally employed, the principle upon which the examination is conducted being the same as in exploring a part with a probe, properly so called; that is, the instrument, which is either straight or curved, and composed of gum elastic or metal, is well oiled and warmed, and then carefully introduced as far as the seat of the obstruction, the distance between which and the external orifice is now determined by looking at the graduated scale upon the surface of the bougie, or by making a scratch upon it with the nail. The examination is completed by insinuating the instrument gently into the stricture, so as to measure its extent and the degree of its resistance. The information thus elicited is generally of the greatest diagnostic and practical value.

Sound.—The instrument employed for exploring the bladder is called a sound, although it is in reality nothing but a probe, blunt-pointed at the distal extremity, and a good deal curved, so as to adapt it to the course and shape of the urethra. It is composed of steel, being perfectly smooth and of a round shape. Its object and mode of use will claim special attention in connection with the diagnosis of vesical diseases, which could not be established satisfactorily in any other way.

Speculum.—Of the value of the speculum as a means of diagnosis in affections of the vagina, uterus, anus, larynx, nose, and ear, it is unnecessary to say anything of a formal character, as it is fully appreciated by every intelligent practitioner. For the exploration of these passages, instruments of various forms and sizes are used, which will be particularly noticed under their respective heads. The uterine speculum, of which fig. 123 affords an illustration, was invented several thousand years ago, but had been entirely lost sight of until it was brought before the attention of the profession early in the present century by Recamier, of Paris, who thus conferred an inestimable boon upon the female sex by opening a new path to the treatment of her diseases. To impart perfection to such examinations a good light, either natural or artificial, is indispensably necessary.

Exploring Needle.—The value of the exploring needle cannot be too highly appreciated by the practical surgeon, as he is obliged to use it in the examination of a great variety

Fig. 122.

Sayre's Vertebrated Probe.

of external affections, the diagnosis of which does not admit of accurate determination in any other manner. On the other hand, however, there is reason to believe that there is no instrument, certainly none of its size, that is more frequently misapplied by the uninformed practitioner, or one which may do a greater amount of harm when used without

Fig. 123.
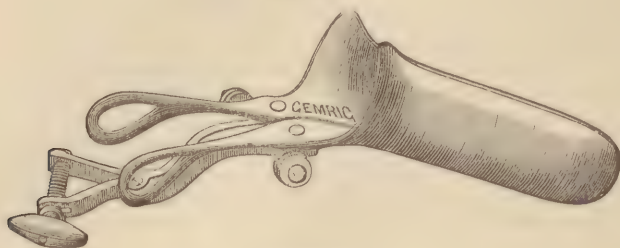
Speculum.

proper judgment and discrimination. Like everything else that is good, it is liable to abuse; a circumstance which cannot be too strongly impressed upon the mind of the young surgeon. I am sure I have seen immense injury, and even loss of life, produced by its careless and reckless use.

Numerous exploring needles are in the hands of the profession; some of which, displaying great delicacy and ingenuity, seem to combine all the advantages that such contrivances are capable of affording, while others are extremely clumsy, and, consequently, very imperfectly adapted for the purpose they are designed to fulfil. The great fault with most of them is that they are too large, thus inflicting an amount of injury upon the affected parts, which, especially in malignant diseases, is often followed by the most disastrous effects, causing, perhaps, not merely severe pain and hemorrhage, but such a change in the vital relations of the morbid growth as to lead to its rapid development, if not to the speedy destruction of the patient. I recollect seeing, some years ago, a tumor upon the hip of a lad, aged sixteen, which, after having been subjected to various examinations by highly respectable surgeons, was at length pierced with a large exploring needle. The swelling, which had been supposed to be nothing but a chronic abscess, and which for some time had been almost stationary, now rapidly increased in volume, ulcerated, and fungated, and in less than a fortnight destroyed life. Dissection showed that the morbid growth was a round-celled sarcoma, the activity of which had been greatly augmented by the changes induced in its vital relations by the injury inflicted by the instrument. A large volume might be filled with a rehearsal of the mischief that has been committed by the exploring needle in the hands of ignorant and careless practitioners.

Exploring needles consist either of a solid cylinder or of a species of trocar and canula, sharp-pointed, fine, and perfectly smooth, so as to facilitate their introduction and easy management. They are made of various lengths and diameters, according to the depth, volume, and nature of the part to be examined. The annexed cut, fig. 124, represents an exploring needle, with a lateral groove. The best instrument of the kind, according to my experience—one which answers every purpose in superficial affections, and which

Fig. 124.

Exploring Needle.

may always be used with the most perfect safety—is the ordinary cataract needle, spear-shaped, and sufficiently stout to prevent it from breaking. This is inserted into the most prominent portion of the tumor or morbid accumulation, with a kind of rotatory motion, the object being to condense, as it were, the edges of the opening to promote the escape of the contents of the swelling, which readily occurs, if they are of a fluid consistence, a drop of the liquid often adhering to the instrument, or resting upon the orifice of the little puncture. When the contents are of a semisolid nature, or the tumor is very deep-seated, the needle should be larger; or, what is preferable, it should be replaced by a very

small trocar, long enough to reach and penetrate the affected structures. Whatever instrument be used, it must not, on any account, be permitted to come in contact with any important vessels or nerves. When the swelling is of unusual bulk, it may be explored at several points of its extent at the same sitting. The little puncture made in the operation should immediately be closed with adhesive plaster or collodion. When the object is to exclude the entrance of air, the instrument may be carried some distance between the integument and the swelling, so as to make the opening somewhat valve-like.

A needle, perforated in its entire length, is occasionally used on the ground of its supposed superior efficacy in exploring deeply seated disease, its great value consisting in the facility of discriminating between different kinds of fluids, or in reaching deeply-seated fluids without the admixture of the superficial.

Kühn, Duchenne, Noeggerath, Hewson, Dresher, and others, have invented exploring instruments for the purpose of extracting a minute portion of a tumor, morbid deposit, or muscular tissue, with a view to a microscopical examination of its structure prior to an operation, the tube employed for this object being furnished with a peculiar contrivance attached to a sliding rod in its interior. Such a procedure, it appears to me, is more ingenious than useful, as its disturbing influence upon the morbid mass can hardly fail at least occasionally, to impart new life and energy to the affected tissues. It possesses, however, an actual value in trichinosis and certain forms of paralysis and muscular atrophy, inasmuch as it enables us to ascertain the precise condition of the muscular tissue, and determine whether any benefit will be likely to accrue from the employment of electricity and other curative agents. The most suitable instruments for such examinations are those of Duchenne and Noeggerath, depicted in figs. 125 and 126.

Fig. 125.

Fig. 126.

Syringe.—The use of the syringe occasionally affords valuable aid in the determination of the nature of a case. In suspected fistule of the bladder, rectum, and some of the other mucous outlets, the diagnosis may often be established, in the most unequivocal manner, in a few seconds, by the injection of a stream of water. Sometimes the fluid may be advantageously colored with indigo. A fistule of the neck, dependent upon organic stricture of œsophagus, may generally be promptly detected by making the patient swallow a liquid of this kind.

The ophthalmoscope, laryngoscope, rhinoscope, otoscope, and endoscope are of great service in the detection and treatment of diseases, difficult, if not impossible, to be reached in any other way. They all essentially consist of two mirrors for concentrating the light upon the object designed to be examined, and, as now constructed, are exceedingly simple, and, for the most part, easy of application.

The *ophthalmoscope*, devised by Helmholtz, who published an account of it in 1851, has been greatly improved by Loring, and is now a very perfect instrument, well adapted to fulfil the intentions of its ingenious inventor.

The *laryngoscope* owes its origin mainly to the genius of Czermak, of Vienna, by whom it was at once brought to a high state of perfection. It is designed, as the name implies, to assist in the explorations of the windpipe, and the only objection to it is the difficulty of its application, few practitioners being possessed of the requisite degree of tact to use it to advantage. The most valuable monographs upon the subject that have yet appeared, are those of Czermak, Turck, Semeleder, Stoerk, Voltolini, Mackenzie, Cohen, Gibb, and Moura-Bourouillon.

The invention of the *rhinoscope* was a necessary consequence of the application of the

laryngoscope in the hands of its distinguished inventor. In exploring the windpipe, it was easy to see the upper part of the pharynx, the orifices of the Eustachian tubes and the posterior nares, and thus arose what may very properly be called the science of rhinoscopy.

To Mr. Toynbee, of London, belongs the merit of introducing an instrument called the *otoscope*, which is of great aid in the examination of the ear, with a view of determining its precise condition in cases of supposed disease. It is of very simple construction, as well as of easy application.

The *endoscope* is employed chiefly for exploring the urethra and the bladder, although it may also be advantageously applied to other canals, as the rectum, vagina, uterus, nose, larynx, pharynx, and ear. It is a contrivance of recent invention, brought to a remarkable degree of perfection by the ingenuity of Desormeaux, Cruise, and other observers. The endoscope of the Dublin surgeon is, in principle, identical with that used in 1824 by Dr. Fisher, of Boston. It consists simply of a tube or speculum, which is inserted into the cavity to be examined; of a mirror of polished silver, perforated at the centre, and placed at an angle of about $45°$; and of a plano-convex lens, of suitable focal length, for concentrating the light.

The use of the *stethoscope*, as a means of surgical diagnosis, is comparatively limited, and it might be altogether dispensed with by those who have a well-practised ear, and are not averse to the employment of immediate auscultation, or the direct application of the ear to the affected parts. Lisfranc thought the stethoscope might be advantageously resorted to for the purpose of detecting crepitus in deep-seated fractures; or, what is the same thing, in fractures covered by a large amount of muscular and other tissues, as, for example, those of the neck of the thigh-bone in very fleshy subjects. Few occasions, however, arise in which such a mode of exploration can be of any real service, and I am not aware that any of our more experienced practitioners ever employ the instrument with this object.

Laennec, in the early part of the century, proposed auscultation as a means of detecting the presence of calculi in the bladder. He thought that it would be particularly serviceable in ascertaining the existence of very small concretions, which, when struck with the sound, emit only a very indistinct noise; and he suggested that, under these circumstances, the stethoscope should be applied to the pubic or sacral region while the instrument is freely moved about in the organ. The recommendation, however, has not met with any particular favor, and there are, I suppose, few surgeons who would feel inclined to cut a patient for stone on such slender evidence of its presence.

The chief value of auscultation, then, is restricted to the examination of diseases of the heart, pericardium, lung, and pleura; and to the investigation of certain lesions of the abdomen, uterus, and ovaries, simulating pregnancy, with a view to the detection of the fœtal circulation. Dry tapping, as it has emphatically been called, would probably be of much less frequent occurrence, if the stethoscope were oftener employed in supposed dropsy in young, unmarried females.

SECT. VII.—EXAMINATION OF THE DISCHARGES.

The discharges, normal and abnormal, from different parts of the body, often furnish the surgeon important diagnostic information. Thus, an habitual flow of tears over the cheek is usually denotive of disease of the lachrymal passages, and necessarily suggests the propriety of a careful examination of them with a view to the detection of obstruction. For a similar reason the surgeon is prompted to inspect the ear in otorrhœa, and the nose when it is the seat of muco-purulent profluvium. The very nature of the discharge informs him of the existence of inflammation, but how that inflammation is produced, whether by the presence of a foreign body, a piece of dead bone, or a polyp, is a question which can only be decided by the most careful scrutiny; requiring, perhaps, the employment of the syringe to wash away the secretion, and repeated inspection before the precise nature of the case can be satisfactorily made out. One of the most important symptoms of inflammation of the maxillary sinus is a flow of pus into the throat; but no surgeon can be certain that it proceeds from that cavity unless he has previously ascertained that there is no disease of the mucous membrane of the nose.

The character of the *sputa* has long been an object of study with practitioners, on account of the useful information which they afford in regard to the existence of particular diseases. Such information is hardly of less value to the surgeon than to the physician, as it apprises him of the presence of lesions which forbid surgical interference, or places

him in possession of useful data respecting the occurrence of pulmonary complications, so common after accidents and capital operations. The reddish streaks in the expectoration excite suspicion of the existence of pneumonia; the rust-colored sputa confirm that suspicion, and at once invest the case with its proper importance. The fetid, putrilaginous matter coughed up in gangrene of the lungs is characteristic of that disease, from whatever cause proceeding. In phthisis, after the occurrence of caverns, the expectorated matter is ejected in distinct, rounded masses, with irregular and indented edges; it sinks in water, and is of a yellowish color, with various shades of ash and even green, and streaked with opaque specks. A discharge of blood by vomiting is denotive of hemoptysis when the fluid is of a scarlet color, and of hematemesis when it is perfectly black. In affections of the throat, attended with thick, mucous or muco-purulent secretion, the sputa are sometimes streaked with blood. The saliva in mercurial stomatitis has a characteristic odor, and the same is true of the discharge which accompanies gangrænoris.

A thick, yellowish discharge, more or less abundant, from the *vagina*, is indicative of inflammation of that canal, of the uterus, or of both, and the addition, of blood may usually be regarded as an evidence of concomitant ulceration. In a chaste woman such a profluvium is generally to be considered as the result of accidental causes; in the courtesan, on the contrary, it at once awakens suspicion of the existence of gonorrhœa or chancroid. In carcinoma of the womb, the disease is attended, in its earlier stages, by hemorrhage, and afterwards, when ulceration has set in, by a foul, purulent, or sero-sanguinolent discharge, more or less copious, and so excessively fetid as to indicate unmistakably the character of the lesion.

In the male, a discharge of matter from the *urethra* generally furnishes useful information respecting the character of the disease under which the individual is laboring. When the discharge is thick, yellowish, and abundant, it is denotive of gonorrhœa, or chancre, though in the latter case it is seldom very profuse; when thin and lactescent, or like the white of an egg, it indicates the existence of gleet, or prostatorrhœa. A large and sudden discharge, especially when no profluvium precedes or follows it, is to be taken as an evidence of spermatorrhœa.

The presence of *spermatozoa* in hydrocele sometimes throws important light upon the source of the water. It has been ascertained that whenever the fluid contains cells of this kind, the disease is generally of an encysted nature; for, although they also occur in ordinary hydrocele, yet the circumstance is so uncommon that it must be regarded as altogether of an exceptional character.

Of the signs afforded by the *renal* and *urinary secretions*, as evidences of disease, either of a local or general character, proper mention will be made in the chapter on the affections of the urinary organs. Here I shall only add that a careful examination of these secretions is often a matter of the greatest importance to the surgeon, especially when he is obliged to decide respecting the propriety of a severe operation, the result of which might be seriously compromised by the existence of organic lesion either of the kidneys or of some other important viscera. Hardly any man, however reckless, would attempt such an undertaking if the urine were loaded with albumen and renal casts.

The existence of disease of the *anus* and rectum, and even the true nature of such disease, may often be satisfactorily inferred by the discharges furnished by these parts. A flow of pure blood, especially during defecation, is generally denotive of internal hemorrhoids; so also if there are frequent evacuations of thick, bloody mucus, either while the person is at the water-closet, or in the intervals of his visits. A narrow, compressed, or flattened state of the feces is indicative of mechanical obstruction, occasioned either by stricture of the rectum, enlargement of the prostate gland, or contraction of the anus. In ulcerated carcinoma of the lower bowel, the discharges are generally very profuse, of a muco-purulent nature, mixed with blood and mucus, and excessively fetid; in fact, characteristic of the nature of that horrible malady.

The matter of certain *abscesses* serves to point out their nature and situation, or their accidental communication with neighboring parts. Thus, in the mammary gland, the fluid may contain milk; in the liver, bile; in the kidney, as when an opening takes place externally, urine. Abscesses of the wall of the abdomen have been known to contain biliary calculi; of the joints, fragments of cartilage and bone. In acute abscesses, the contents are thick and yellowish; in chronic, or strumous, thin and slightly greenish, with an intermixture of small opaque, whitish flakes, resembling grains of boiled rice.

The discharge accompanying *ulcers* generally affords valuable hints respecting the

nature of their action.   Healthy granulating ulcers or wounds always yield a thick, yellowish pus, possessing all the properties of laudable pus, as described under the head of suppuration ; when, on the contrary, their action is unhealthy, the discharge is thin and bloody, ichorous, sanguinolent, and more or less irritating.   In carcinomatous ulcers, the discharge is generally profuse, foul, devoid of pus globules, and excessively fetid. In ulcers of the bones, it is ichorous and irritating ; never healthy, so long as there is any diseased osseous tissue.

The *odor* emitted by a part in a state of disease sometimes supplies important data for the diagnosis of a case.   Most readers are familiar with the remarkable anecdote related of J. L. Petit.   Travelling through Germany, this celebrated surgeon, while stopping at an inn to change horses, was struck with the odor of gangrene, which he distinguished from several others, hardly less offensive.   Not understanding the language of the country, he made his wishes known to a female, who showed him into an adjoining room, where he found a man apparently moribund from a mortified intestinal hernia.   Happy in being able to render him some assistance, he carefully dressed the parts, and meeting, before he set out upon his journey, with a French physician, he instructed him in the future management of the case.   Upon his return, five months afterwards, he had the gratification to learn that the man had completely recovered his health without a stercoraceous fistule.

The odor attendant upon ozæna is characteristic ; no one that has ever perceived it can mistake it.   The contents of an abscess at the verge of the anus always emit a fecal smell ; a peculiar fetor accompanies the formation of a urinary fistule, and no one can be deceived by the odor of the breath in salivation.   In hospital gangrene the stench is so remarkable that, once noticed, it can never be forgotten, although it is so unlike everything else of the kind as to render it impossible to define or describe it.   The odor which accompanies gangrene of the mouth of children is unmistakable.   The diagnosis of ulcerated carcinoma of the uterus may often be established by the sense of smell alone.   Large wounds in a state of profuse suppuration not unfrequently exhale a peculiar nauseous or sickening odor, in some degree characteristic of the attendant action.   The pus of a scrofulous lymphatic gland, for a long time pent up, is sometimes horribly fetid.   A smell, similar to that of a macerating tub, often attends abscesses depending upon caries of the spine. In all these cases, as well as in many others that might be adduced in illustration of the subject, it is probable that the peculiarity of the odor is due partly to the admixture of the natural secretions of the affected structures.

CHAPTER XIV.

MINOR SURGERY.

Minor Surgery comprises an account of some of the more common instruments used in surgery, of the mode of making incisions, or of performing the elementary operations, the establishment of issues, the introduction of the seton, the application of the actual cautery, bleeding, and the art of bandaging and of dressing.   As some of these topics have already been incidentally discussed, especially in the chapter on inflammation, I shall here confine myself to the consideration of those that have not yet been touched upon in previous parts of the work.

SECT. I.—INSTRUMENTS.

Instruments are as necessary to the surgeon in the execution of his operations as they are to the mechanic in the performance of his daily labor.   But as the best workman employs the fewest tools, so the best operator employs the fewest instruments ; and to the man of science and taste nothing is more disagreeable than an ostentatious display of such material.   A few articles, well selected, and kept in proper order, ready to do their work at the shortest notice, are all that any surgeon really requires for the successful performance of nearly every operation that he may be called upon to undertake.   The simplicity of his armamentarium often affords a better idea of his skill and science than the most daring feat upon the operating table.

The elementary and really important instruments are very few in number; they are the scalpel, needle, saw, forceps, probe, and director, which are the parents of nearly all the numerous and diversified surgical contrivances found in the shops of the modern cutler. With a little modification the scalpel is converted into the bistoury, the lancet, and the amputating knife, and may thus be made to answer all the purposes required of a cutting instrument. The same needle with which a suture is made, may, with a little difference of size and shape, be readily used for couching and lacerating a cataract, or inserting a seton. The saw may be modified without limit, and the same is true of the forceps, whether intended for dissection, dressing, or the division of bone. The probe, which, from its great usefulness, may almost be regarded as another finger, varies in size and shape, from the little delicate, almost thread-like instrument devised by Anel for examining the lachrymal canal, to the sound employed by the lithotomist for exploring the condition of the bladder. The grooved director, which serves to guide the knife in the division of the soft parts, as in operations for hernia, impermeable stricture, and stone in the bladder, is, in fact, nothing but a modification of the ordinary probe.

The *knives* generally in use among surgeons for the more ordinary daily operations are the scalpel and bistoury, of various sizes and shapes, so as to adapt them to the exigencies of each particular case. All such instruments should have a tolerably large handle, and I decidedly prefer one that is somewhat rough, as being less likely to slip from the fingers when wet with blood. The blade should be rather long and slender, gradually tapering to a point, which should be quite sharp, or, at any rate, not at all rounded. In some operations, a double-edged, spear-shaped knife is very serviceable, as in the extirpation of

Fig. 127.   Fig. 128.   Fig. 129.   Fig. 130.   Fig. 131.   Fig. 132.
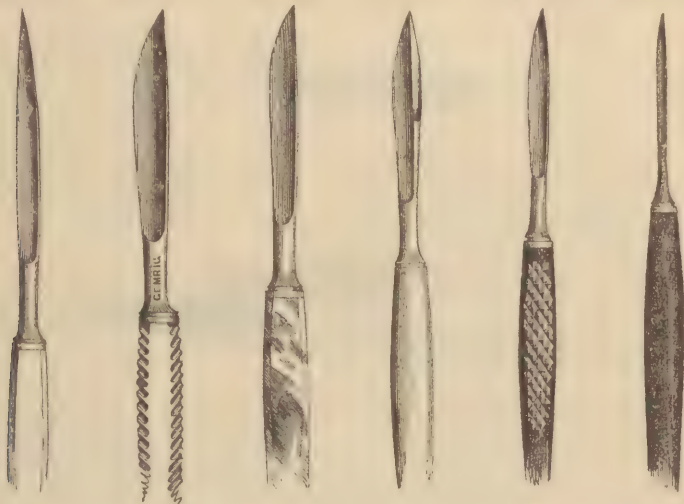
tumors, and the extraction of cataract. Finally, it is sometimes advantageous to have a knife the handle of which terminates in a semisharp steel edge. Such an addition is occasionally of great use in the excision of morbid growths. The above figures afford a good idea of the more common of scalpels.

Fig. 133.

The *bistoury* differs from an ordinary scalpel chiefly in being longer and more slender; it may be straight or curved, with a sharp or blunt extremity. It is often made so as to

open and shut like a penknife, as in fig. 133; but the best instrument of the kind is one with a fixed handle. The term bistoury has been supposed to be derived from Pistorium, the name of a town where it was at one time extensively manufactured. Particular forms of this instrument, invented for particular operations, will be alluded to in different parts of the work.

The adjoining sketches afford good illustrations of the ordinary forms of the bistoury: fig. 134 represents the sharp-pointed instrument, and fig. 135 the probe-pointed.

Fig. 134.

Fig. 135.

There is hardly any operation in which it is not necessary to use *forceps*. The instrument usually employed is the common dissecting-forceps, represented in fig. 136. In some cases, as when the object is to pinch up a delicate structure, as the conjunctiva, or

Fig. 136.

a very thin layer of fascia, a pair of forceps provided with a small tooth, as represented in fig. 137, will be found not only very convenient, but almost indispensable.

Fig. 137.
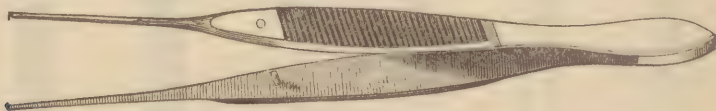
Scissors are essentially nothing but two knives united by a screw, and furnished each with a ring-handle; if thin, and properly sharpened, they divide the tissues with little or no contusion, and may be employed for a great variety of purposes. They are particularly valuable in many of the more delicate operations upon the eye. They may be straight or curved on the edge or on the flat, pointed or blunt at the extremity, or one blade may be sharp and the other blunt. The rings should always be large for the ready accommodation of the thumb and finger. Figs. 138 and 139 exhibit the two principal forms of surgical scissors.

Fig. 138.
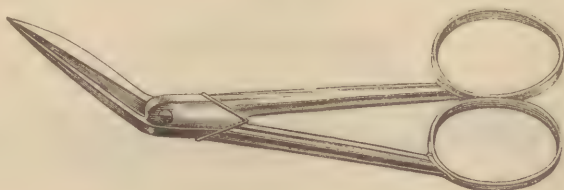
For holding the flaps out of the way in performing certain operations, especially such as involve the removal of morbid growths, among the more deep-seated structures, or the exposure of arteries, instruments, called *retractors*, are often of great service, and should

find a place in every well-arranged operating case. The best instruments of this kind are made of flexible metal, mounted upon handles.

Fig. 139.
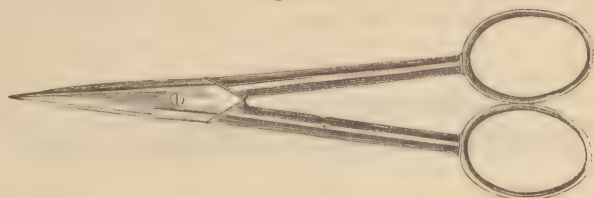
For holding and pulling out morbid growths, such as deep-seated tumors of the neck or thigh, and for drawing down the cervix of the uterus in operating for vesico-vaginal fistule, as well as for other purposes, a Museux's forceps, shown in fig. 140, or a common

Fig. 140.
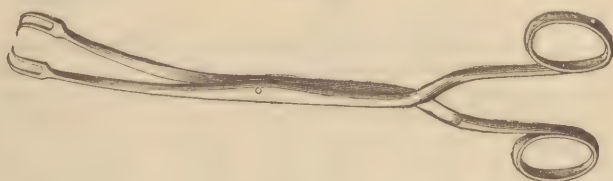
volsella, is of great use. The teeth being plunged into the morbid mass, the instrument is either held by the surgeon himself, or the requisite traction is exerted by an assistant.

Fig. 141 represents another contrivance, which may be used for a similar purpose, its prongs being firmly screwed into the substance of the morbid growth.

Fig. 141.

The forceps shown in fig. 142 are very serviceable in the extirpation of large tumors of the uterus, in grasping, holding, and pulling down the morbid growth. Their mode of action is apparent at a glance.

Fig. 142.
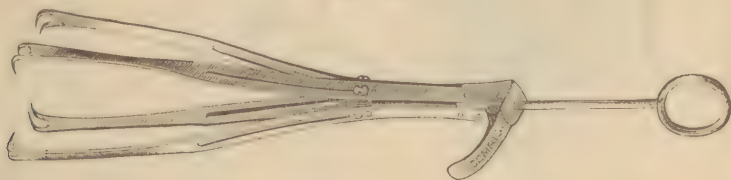
The grooved *director*, fig. 143, is indispensable for laying open sinuses and fistules, in exposing arteries, and in dividing the coverings of herniæ and of deep-seated tumors. It is generally blunt at the extremity, but in some cases it must be somewhat sharp, so as to effect more easy penetration of the tissues. The double director, fig. 144, is very serviceable in operating for strangulated hernia and in the extirpation of tumors with unusually firm and extensive adhesions.

Fig. 143.

The *trocar*, represented in fig. 145, and so called from the circumstance of having a three-edged extremity, consists of a cylindrical rod, passed through a silver canula. It

is employed for drawing off various kinds of fluids, as serum and pus. Its use, at the present day, is chiefly confined to the removal of water from the chest, abdomen, and vaginal tunic of the testicle. There is a contrivance of this kind with a flat, spear-shaped extremity, but it is not much employed, its canula being more liable to obstruction than that of the round trocar. Special instruments are employed for particular operations.

Fig. 144.

Fig. 145.
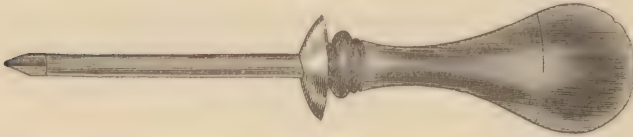
The *pneumatic aspirator* is simply a delicate trocar attached by means of a short gum tube to a bottle, which is exhausted of air by means of a syringe, the invention of which, apparently, belongs to Palletan, although it has been claimed by other surgeons, as Dieulafoy, Potain, and Protheroe Smith. The instrument represented in fig. 146, may be advantageously employed for removing fluids from the thoracic cavity in empyema, for emptying abscesses and distended joints, and for evacuating the urine in retention from enlargement of the prostate gland, organic stricture of the urethra, and other causes. It is also used for withdrawing gas and the fluid contents of the intestine in strangulated

Fig. 146.

Fig. 148.

Potain's Aspirator.

Fig. 147.

Suture needle in fixed handle, useful in tying erectile and other tumors.

hernia, and for diagnosticating hydatids, abscesses, and serous cysts of the liver and other abdominal viscera. The trocars are of different sizes, for ready adaptation to various contingencies, and range in number from three to half a dozen. Many modifications of the original instrument are in use.

Surgical *needles* are straight, curved, round, or flat, and of various sizes, as in fig. 147. In some instances, as when it is necessary to take a deep stitch, sew up a fissure of the palate, penetrate an unusually hard structure, or encircle a deep-seated artery, it is convenient to secure the instrument to a handle, as in fig. 148. In sewing up large wounds a needle at least two and a half inches in length, perfectly straight, like a sewing needle, slender, and very sharp, will be found to be the most convenient.

For operations upon the bones, the *surgical engine*, devised by Dr. Bonwill, of this city, is destined to come into common use in hospital practice. It consists, essentially, as is represented in fig. 149, of a frame, a driving wheel, provided with a crank, and a flexi-

Fig. 149.
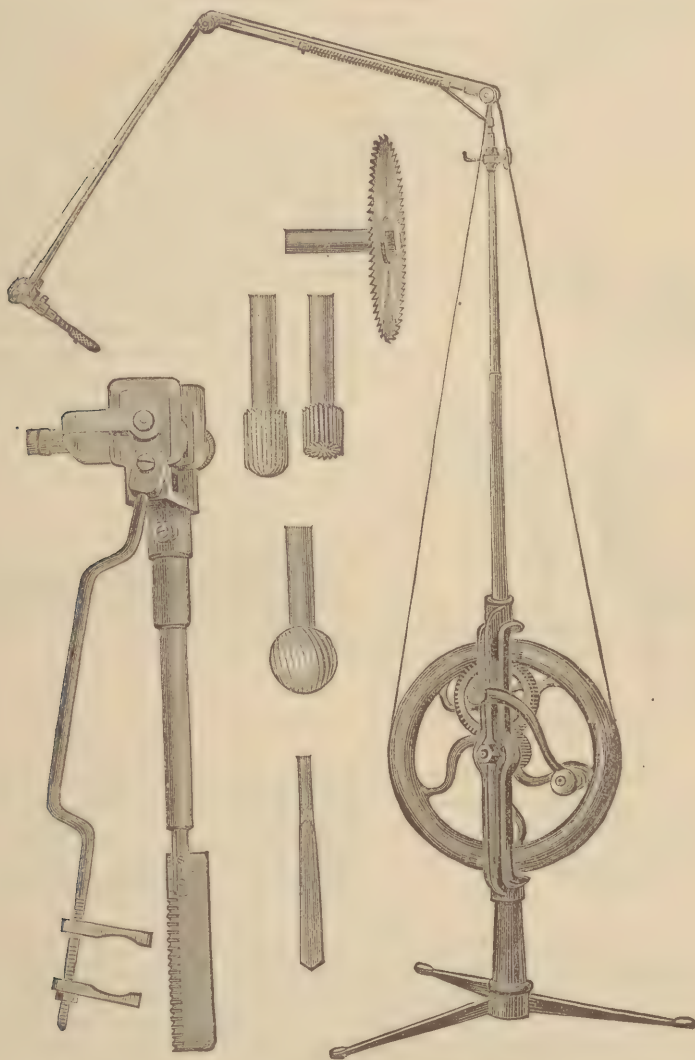
Bonwill's Surgical Engine.

ble arm, to the extremity of which a hand piece is fitted for the reception of the drills, burrs, and saws, the power being transmitted by a cord passing from the wheel to the hand piece. The great speed that can be imparted to the instruments, through which they are made to revolve at the rate of fifteen thousand revolutions in the minute, enables the surgeon to perform operations with great rapidity, and with comparatively little pain. The circular saw is especially useful in dividing the lower jaw, in removing the ends of the bones in ununited fracture, in facilitating the withdrawal of sequesters, and in incising

bones affected with osteomyelitis. I have found the burrs very serviceable for shaving off the alveolar process in the neuralgia of edentulous jaws, for removing tumors of the maxillæ, for making the necessary openings in excision of the second and third branches of the fifth pair of nerves, for effecting riddance of redundant callus, for the relief of certain deformities of the nose, for the removal of carious bone, and for the extirpation of the coccyx. The drills are employed for making openings for the insertion of ivory pegs or wire in cases of false joint. The reciprocating saw is useful for subcutaneous division of the long bones for the correction of various deformities. It is provided with an attachment for fixing the bone previous to the section of its ends in pseudarthrosis, when, from the comparatively inaccessible position of the false joint, it is difficult to bring the fragments through the wound, as when the upper portion of the femur is affected.

The *syringe* forms an important element in the armamentarium of the surgeon. Great improvement has taken place of late years in the manufacture of this class of instruments, both as it respects their excellence and their variety. For washing out the vagina and rectum the most eligible syringe is Davidson's, fig. 150, and the same contrivance may be advantageously used for throwing fluids, whether simple, medicated, or intended as food, into the lower bowel. The hard rubber syringe, capable of holding from half a pint to a quart, is also well adapted to the object, and there are cases in which it is to be preferred, as when an enema requires to be thrown high up into the bowels. Syringes for the urethra, eye and ear will receive separate notice in the chapters on diseases of those organs. For cleansing wounds and ulcers nothing answers so well as a tin tank, provided with a gumelastic tube from a yard to a yard and a half in length, and fitted with a delicate nozzle capable of being insinuated into any recess, however small. When the object is to wash out the vagina, or any deep cavity,

Fig. 150.
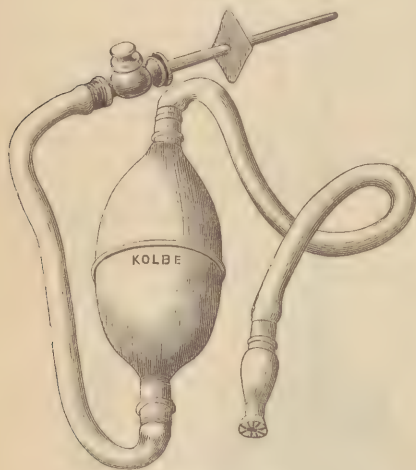
Davidson's Syringe.

Fig. 151.
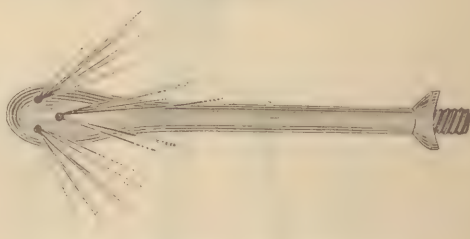
Vaginal Syringe Nozzle with Reverse Current.

covered with blood or adherent secretions, a large nozzle with numerous large apertures may generally be used with advantage. A syringe nozzle, fig. 151, with a reversed current, is another serviceable contrivance in such a condition.

SECT. II.—INCISIONS.

It is not my intention to enter into any minute details respecting the manner of holding the knife, in operating upon the living subject, as this is a kind of information which should be acquired in the dissecting-room, in connection with the study of surgical anatomy. A few rules, concisely and plainly stated, will be quite sufficient for the purpose, and will enable any man of sense to execute, with facility, neatness, and celerity, any operation he may be called upon to undertake. Anything like a flourish for the sake of display or the hope of attracting the applause of the vulgar, is as repugnant to good taste as it is out of place upon such an occasion.

There are four principal positions in which the knife may be held for operative purposes, and with these every surgeon should make himself familiar. The annexed sketches will serve to convey a better idea of their character than any description, however elaborate. They are generally distinguished by the prefix of first, second, third, and fourth.

In the first position, fig. 152, the knife is held like a writing-pen, between the thumb

and the first two fingers, which grasp the instrument gently yet firmly at the junction of the handle with the blade, the edge being inclined downwards or upwards, according to

Fig. 152.
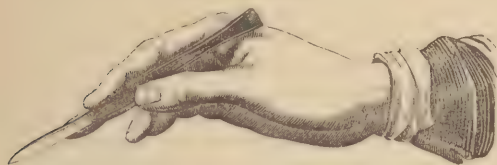
Fig. 153.

the intentions of the surgeon.   This position is a very common one, as it is employed in a great variety of operations, as lithotomy, the extirpation of tumors, herniotomy, and the extraction of cataracts.

In the second position, fig. 153, the handle of the instrument lies in the palm, the thumb and middle finger holding it at its anterior extremity, while the index finger is slightly extended along the back of the blade, the ring and little fingers assisting in supporting and steadying the handle.   The edge of the blade is inclined downwards or upwards, according to circumstances.

In the third position, fig. 154, the knife is held like the bow of a violin; that is, the instrument, turned away from the palm, is lightly balanced in the hand, the four fingers being applied against one side, and the thumb against the other.   In the dissection, the blade is usually held somewhat sidewise, and the operation is performed chiefly by alternately flexing and extending the wrist.

In the fourth position, fig. 155, the knife is held like an ordinary carving-knife, the handle, which inclines towards the ulnar margin of the wrist, being firmly grasped by, and almost completely concealed in, the hand, the tips of the last three fingers nearly touching the hypothenar eminence.   This position is chiefly used in the amputation of the larger limbs, and, occasionally, in the extirpation of huge superficial tumors, when the surgeon wishes to produce a rapid and brilliant effect.

The incisions employed in operative surgery may be conveniently reduced to three principal ones, the straight, curvilinear, and angular, which are the parents of all the rest. In executing these incisions certain rules should be observed, of which the most important are the following:—

Fig. 154.
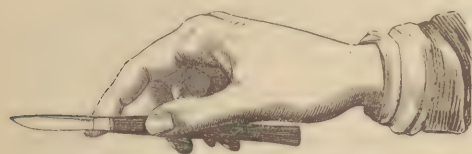
Fig. 155.

1. The knife, whether a bistoury or scalpel, should be in as complete a condition as possible, being perfectly sharp and clean, and as light as may be consistent with the necessary strength; its size should also be carefully adapted to the occasion.

2. Before commencing the incisions, care should be taken to stretch, extend, or tighten the skin, which is done either by the surgeon alone, or partly by him and partly by his assistants.   Attention to this rule is of great importance in numerous operations, as it not only expedites the movements of the knife and imparts precision to the incisions, but, what is often a matter of the greatest consequence, enables us to save integument, as, for instance, in case of amputations and in the removal of benign tumors.

3. The incisions, of whatever shape, should be sufficiently large to answer the purpose, for which they are designed, being made so, if possible, before the dissection is begun, as this generally greatly facilitates the removal of the parts, or their separation from each other.   The principal exception to this rule is where the operation involves the division

of large vessels, which, if they were all wounded at once, might be productive of serious hemorrhage.

4. The superficial incisions should be of equal depth throughout, the knife being entered perpendicularly at one extremity, and brought out similarly at the other, the object being the avoidance of what is called a tail, or a partial division of the integument at each end, as would inevitably happen if the point of the instrument were introduced obliquely. A gentle but steady sawing motion of the knife should be employed rather than firm pressure.

5. In dividing the common integument, the knife should always, if possible, be carried parallel to the axis of the parts to be exposed or removed, in order that there may be no interference with any important vessels or nerves, which usually run in that direction. Another great point to be gained, in observing this precaution, is that the flaps are prevented from bagging, and so serving as receptacles for the lodgment of blood and inflammatory deposits.

6. The incisions should be made as rapidly as possible, seeing that the division of the common integument is generally the most painful part of an operation. Moreover, while they should be sufficiently extensive for the object in view, care should be taken not to make them larger than is necessary.

7. All cutaneous incisions should be made with special reference to the prevention of unseemly scars. To do this successfully is not always either easy or even practicable. As a general rule, the object is best attained by carrying the knife in the direction of the muscular fibres of the part, or in the line of its wrinkles. Thus, in operating on the forehead, the surgeon will best attain his wishes if he makes his incision horizontal, not oblique, much less perpendicular. In operating upon the lower jaw, or in extirpating tumors from this region, the incision should be so directed as to run along the base of the bone, which will thus offer the best chance of concealing the resulting cicatrice.

8. The operator, in the exercise of his functions, must be careful not to wound himself, his assistant, or his patient; an occurrence as awkward as it is unseemly, and one that will seldom happen, if everything be properly arranged beforehand.

The straight incision may be made either from without inwards, or from within outwards. The former method is usually adopted in the ordinary operations, as in the extirpation of tumors, in opening abscesses, and in the ligation of arteries. Where great caution, however, is required, as in operating for strangulated hernia, or in the removal of morbid growths in front of the neck, the incision must be made from within outwards. For this purpose a fold of integument is pinched up and held by the surgeon and his assistant, while its base is transfixed by the knife, and divided by making the instrument cut its way out. The dissection is afterwards conducted upon a grooved director.

Occasionally, as in operating about the neck, especially when the object is the removal of a large tumor at the angle of the jaw, the incision may advantageously be made in a curvilinear direction, either like an Italian *f*, or in the form of a semiellipsis,

Fig. 156.

as in fig. 156. The chief reason for this procedure is that, while it affords the operator more room, it leaves a more seemly cicatrice.

The elliptical incision consists of two curvilinear cuts, meeting at their extremities, as in fig. 157. It is chiefly employed in the extirpation of tumors, where the object is to remove along with the diseased mass a portion of redundant or unhealthy integument. The incisions are made rapidly, in the usual manner, one after the other, the skin being properly stretched, and care taken not to cut away more than is absolutely necessary, since it will otherwise

Fig. 157.

be difficult, if not impossible, to bring the edges of the wound together, after the operation is over, so as to obtain a good and rapid union. Not a little judgment is frequently required to determine, in a given case, how much integument may conveniently be preserved or removed; the surgeon, remembering how contractile the skin is, will generally be cautious how he sacrifices it. Even if the flap is unseemly immediately after the operation, a few days will generally suffice to reduce it to a proper shape and size.

Two semielliptical, crescentic, or semilunar incisions, as in fig. 158, may sometimes be advantageously made, also with the object of removing a portion of integument, as for instance, in extirpating a diseased mammary gland.

Fig. 158.

The incisions may be directed vertically, obliquely, or horizontally, as may seem most suitable. The angular incision may be used for various purposes, as in the extirpation of tumors, herniotomy, excision of joints, the exposure of diseased bone, and in the transplantation of flaps for the restoration of lost or mutilated parts. It may be made in different ways, but commonly so as to repre-

sent the shape of some letter, as in the subjoined figures, according to the exigencies of the particular case.

Fig. 159.   Fig. 160.   Fig. 161.   Fig. 162.   Fig. 163.   Fig. 164.

In dissecting up the flaps, made by these different incisions, the instrument should, as a general rule, be kept in close contact with the parts to be removed ; the knife should be swept along as rapidly as may be consistent with safety ; and good use may commonly be made of the fingers, which will in most cases be found altogether preferable to the forceps. Special regard should always be had to the prevention of hemorrhage. If well-trained, intelligent assistants be at hand, there will generally be no necessity for tying every little artery as soon as it is divided ; the instant it springs, a finger is clapped upon it, and thus the operation proceeds to its completion, when, satisfactory clearance being effected, the ligation is at once promptly entered upon, and continued until every bleeding vessel is properly secured.

When the dissection involves the exposure of an important structure, as a large artery, a strangulated hernia, or a cystic tumor, which it is desirable not to pierce, the tissues must be divided layer by layer upon a grooved director gently and cautiously insinuated beneath them ; or they may be pinched up with a pair of forceps, although this is both less elegant and less safe than the other method. In performing this part of the operation, the successive divisions must be effected in the line of the external incisions, the best knife for the purpose being a narrow, probe-pointed bistoury.

SECT. III.—AVULSION, ENUCLEATION, LIGATION, AND CRUSHING.

1. *Avulsion.*—Instead of cutting away morbid growths with the knife or bistoury, removal is sometimes effected by avulsion, or by twisting and tearing. It is in this way that the surgeon usually deals with polypoid tumors of the nose and uterus, the agent that is employed for the purpose being a suitable pair of forceps, with which the tumor is seized and broken off, by rotating the instrument gently yet firmly upon its axis. All active, sudden, or forcible pulling is avoided, as tending to inflict serious mischief upon the parts around by lacerating and injuring them to an undue extent ; or, as in the case of the nose, perhaps dragging away the turbinated bone, or, as in that of the uterus, inverting that organ, or pulling it down beyond the vulva. Moreover, copious hemorrhage, intense pain, and severe shock are liable to follow such rude measures.

Avulsion is sometimes advantageously practised in the extirpation of tumors developed in and among the tissues, especially when they are deeply situated, or when they lie in the immediate vicinity of large vessels, which it would be hazardous to approach with the edge or extremity of the knife. Under such circumstances, the finger may occasionally advantageously take the place of the cutting instrument, the connecting structures being forcibly lacerated, and the mass twisted and lifted out of its bed. This mode of procedure is often resorted to in the removal of tumors from the neck and parotid region dipping deeply down behind the base and angle of the jaw, in close proximity with the pharynx and the large cervical vessels and nerves, where a false movement with the scalpel might instantly be fatal. It is astonishing what little bleeding frequently follows operations thus performed, and how well the parts generally heal after such manipulations. One reason why there is usually so little hemorrhage is that the vessels are torn, instead of being evenly divided, as they are in the ordinary procedure.

2. *Enucleation.*—Enucleation, another species of avulsion, is often advantageously employed in the extirpation of fatty, fibrous, and sarcomatous tumors. The integument, having been thoroughly divided over the morbid growth, along with its capsule, if there be any, the diseased structures are rapidly peeled out either with the finger, or with the handle of the scalpel. In certain cystic tumors the bag with its contents may often be peeled off bodily, or its cavity being laid freely open, and its contents evacuated, the walls of the cyst may be pulled away with the forceps.

3. *Ligation.*—There are certain operations in which the removal of the diseased parts is effected chiefly through the agency of the ligature, which may be constructed of silk, flax, or gum elastic. Of this mode of procedure familiar examples are afforded in the

removal of hemorrhoidal tumors, polypoid growths of the nose, vagina, uterus, and anus, and nævoid formations about the face, forehead, and other regions of the body. The ligature may be applied either directly to the part by the fingers, or by means of a needle, and should be drawn with sufficient firmness to strangulate the included structures, as the object is to cut off the supply of blood, and cause an eschar. Occasionally the ligature is used subcutaneously, as in case of nævoid growths, often involving very interesting and complicated operations. Instead of the ligature, a silver wire is sometimes used, either by itself, or by means of a double canula, as in fig. 165.

Fig. 165.

Double Canula.

4. *Crushing.*—Parts, again, may occasionally be removed by a process of crushing, as proposed by Chassaignac, of Paris, the instrument which he has devised for that purpose being called the *écraseur;* the inventor hoping thus to meet certain contingencies in operative surgery which he, in common with others, had frequently encountered in practice, and which he supposed could not be overcome in any other manner. His chief object was to supply a substitute for the ligature in the removal of certain tumors, as hemorrhoids, and polyps of the vagina and uterus. The idea seems to have been to contrive an instrument that should combine the security of the ligature with the rapidity of the knife, thus preventing hemorrhage and pain, and promptly ridding the part of abnormal structures. The écraseur, as might be supposed, was originally rude and clumsy, but, by the ingenuity of surgeons and cutlers, has been rendered very graceful and convenient, if not absolutely perfect.

The annexed sketch, fig. 166, affords an excellent representation of the shape and construction of the instrument, as manufactured by Gemrig, Kolbé, and others of this city. It will be perceived that it essentially consists of two pieces, a sheath, barrel, or tube, either flattened or cylindrical, and of an articulated chain, attached to a steel rod, lying within the sheath, and moved by a handle. The chain is constructed upon the same principle as the ordinary chain saw, but the links are stronger and perfectly obtuse, except when it is desired to combine division with crushing, when their edges are somewhat bevelled. The instrument is made of different sizes and shapes, so as to adapt it the more readily to the various cases presented in practice. The chain, unless constructed with great care, is very liable to break, especially if used for the removal of dense, indurated structures, the division of which requires a good deal of force.

One great trouble in regard to the écraseur is the difficulty of managing the flexible chain, especially in the removal of fibrous and other growths of the vagina and uterus. To remedy this defect, Dr. J. Marion Sims has added a pair of dilating forceps with spring blades, by which this portion of the instrument is rendered so stiff that it may be introduced into almost any cavity with the same facility as a probe.

Fig. 166.
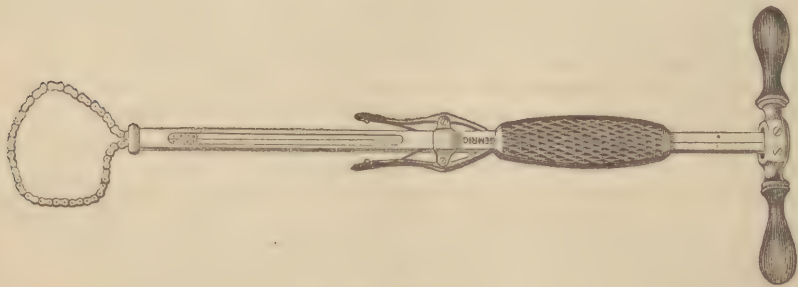
Écraseur.

The smaller variety of écraseur, in which, as represented in fig. 167, the articulated chain is replaced by one or more strands of iron wire, will be found convenient for the removal of polypoid and superficial vascular growths, as well as for laying open fistulous tracks.

The écraseur is less frequently employed now than formerly, and the class of cases to which it is more particularly adapted is much better understood. Its use, at present, is very much restricted to the removal of various kinds of tumors, especially hemorrhoidal, nævoid, and ovarian, and of the tongue, penis, prepuce, and neck of the uterus. The

Fig. 167.

Wire Écraseur.

advantages that may be fully claimed for it are, first, the rapidity of the operation, which is greater than that with the ligature, although less than with the knife, the instrument acting more powerfully upon the tissues embraced in its loop; secondly, the prevention of shock, the chain doing its work gradually and almost imperceptibly, so as hardly to afford the system an opportunity of taking cognizance of what is going on; thirdly, the protection of the part against hemorrhage, the vessels being placed in a condition similar to those in a lacerated and contused wound; and, lastly, the making of a smaller and less exposed wound than either the ligature or knife, followed by less inflammation and more rapid cicatrization.

The principal rules to be observed in the application of the écraseur are the following. In the first place, if the tumor has a broad base, it should, if possible, be pedunculated, by drawing it away from its points of attachment, and casting a ligature around it, its base having previously been transfixed by one or two stout needles. When the coverings of the morbid growth are unusually hard, or insensibly lost in the surrounding parts, a gutter may be formed in them with the knife, preliminary to the application of the chain. Secondly, the division of the tissues is to be effected slowly and gradually, not rapidly or by fits and starts, and for this purpose the handle of the écraseur should be turned only about once every ten, twenty, twenty-five, or thirty seconds. The time occupied in the entire operation must of course vary according to circumstances, from five minutes, as the average minimum, to twenty minutes, as the average maximum. The great objection to a rapid operation is the danger of hemorrhage. Thirdly and lastly, the patient, during the whole procedure, should be under the influence of an anæsthetic, otherwise the pain will be extreme, especially in the earlier stages.

The subsequent treatment is very simple. If pain arises when the patient wakes from the effects of the anæsthetic, a full anodyne is given, the part is kept at rest in an elevated position, under the influence of water-dressing, and any constitutional symptoms that may show themselves are met as they occur, precisely as after any other operation. The wound generally heals in a very short time, with very little appearance of inflammation. I am not aware that the application of the écraseur has ever been followed, in cases at all adapted to its use, by pyemia, or any grave constitutional effects, and this is certainly one of the strongest arguments that can be urged in favor of its employment.

SECT. IV.—SKIN-GRAFTING.

Cicatrization of ulcers and wounds may often be greatly accelerated by the transplantation of skin, or skin-grafting, a practice the introduction of which has been generally, but unjustly, ascribed to Dr. J. L. Reverdin, who did not call attention to it until 1869, fifteen years after Professor Frank H. Hamilton had published an account of his first operation in a paper entitled "Old Ulcers Treated by Skin-grafting," published in the New York Journal of Medicine for 1854. His patient had a large wound, caused by the fall of a heavy stone fifteen months previously, and attended with so much loss of skin, as to render Nature unable to effect a cure. To cover this gap, Hamilton transplanted a portion of integument from the opposite limb, not sufficient, however, to take in the whole surface. In three

Fig. 168.
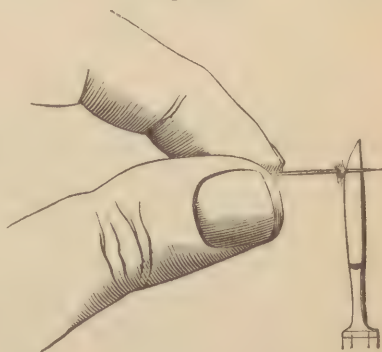
Cutting Grafts.

months the cicatrization was complete, the new piece of skin having grown from its periphery in every direction, and in the end acquired nearly twice its original size. By this operation, which foreshadowed the whole principle involved in skin-grafting, the New York surgeon hoped to establish, as he expressed it, "a new centre of life on an oasis, from whose outer verge a true and healthy vegetation shall advance in every direction over the exhausted soil." To the French surgeon, however, is unquestionably due the credit of introducing and generalizing skin-grafting, or the insertion of minute grafts at various points of the exposed surface, now so generally practised. Availing himself of a knowledge of the physiological law that cicatrization always begins at the periphery of an open surface, he happily conceived the idea of implanting small pieces of skin upon the granulations of wounds and ulcers, in order to afford these bodies, as it were, so many points of departure for the formation of new integument by virtue of the proliferation of their own cells. A very simple plan, both bloodless and painless, which I believe originated with Professor Hodgen, of St. Louis, and which is represented in fig. 168, consists in raising portions of the skin, of the size of millet seeds, with a needle and detaching them with a small knife. The grafts, which include only the epidermis with its mucous layer, and which should be taken from the inner surface of the upper arm of the patient himself to avoid the risks of syphilitic inoculation, are then placed flat upon the raw surface, at a distance of about three-quarters of an inch from one another, and confined with a layer of patent lint, spread with simple

Fig. 169.
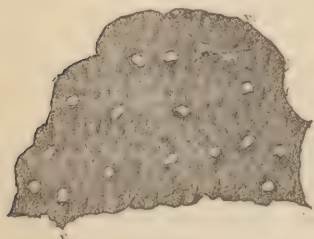
Skin-grafting.

cerate, and supported with adhesive strips and a roller, smoothly and lightly applied. If the granulations are uncommonly large and firm, the grafts are inserted into slight incisions, to afford them a more secure hold. The dressings are allowed to remain for four or five days, when the buds will generally be found to be firmly attached, as in fig. 169. If the buds are very small, they may be so completely imbedded and hidden in the granulations as to be quite invisible for a short time. Soon, however, a bluish-white, opaque speck appears—a little island, as it were, upon the raw surface—indicative of their presence, and of the gradual development of new cicatricial tissue. The new skin thus formed makes a firmer and sounder scar than one formed in the ordinary manner, and therefore is much less liable to fall a prey to inflammation and its consequences. One of the prerequisites to the success of this process is the existence of healthy granulations, and it is well, when the ulcer is very large, not to insert too many grafts at one time, but to trust to consecutive transplantations as more likely to answer the object, which is to impart new life and vigor to the whole surface.

Experiments performed by Guyon and others show that skin-grafting is nearly as successful when practised with epidermic scales as when it is done with bits of skin. Professor Hodgen has obtained excellent results simply by dusting the granulating surface with scrapings of this kind, which, it would seem, are capable of imbibing nourishment, and of generating germinal cells for the development of new epithelium.

It has generally been supposed that the success of skin-grafting is essentially due to the presence of epithelium; but that this is not true has been clearly proved by the experiments of Professor Howard, of New York, who has obtained precisely similar results from grafts of bits of muscle, inserted into granulating wounds.

SECT. V.—SPONGE-GRAFTING.

It has long been known that fibrinous lymph or a clot of blood becomes organized by extension into it of the bloodvessels of the surrounding tissues, those substances playing merely a passive part in situations in which they are replaced by cicatricial tissue. Recognizing these facts, Dr. D. J. Hamilton, of Edinburgh, in 1880, conceived the idea of resorting to very fine porous sponge as a framework for the construction of new material for filling up the deficiencies of ulcers and large surgical wounds; and his experiments demonstrate that a firm cicatrice, which is less contractile than an ordinary cicatrice, may be obtained in this way. The only practical objection that can be urged against this method is that the healing process does not appear to be expedited, since in one of his cases five months were required to reduce an ulcer from a diameter of five inches to that of an inch and a half. In performing the operation the wound should be

accurately filled with one or more pieces of sponge prepared by dissolving out the animal matter by dilute nitro-hydrochloric acid, subsequently washing in liquor potassæ, and then steeping in a one-to-twenty carbolic solution. A piece of protective is placed over the surface and covered with lint soaked in a one-to-twenty solution of carbolic acid in glycerine, and on this a pad of boracic lint, oakum, or antiseptic gauze is confined by a bandage. At the expiration of about five days, the interstices of the sponge will be found to be filling with granulation tissue and bloodvessels, and cicatrization will commence as soon as the new tissue has attained the level of the surrounding skin, at which time the sponge will have entirely disappeared. Throughout the treatment the wound and the discharge must be maintained in an aseptic condition, irrigation with the carbolic solution being resorted to if at any time there is a putrefactive odor. A healthy granulating surface is not an essential requisite for success.

SECT. VI.—ABSTRACTION OF BLOOD.

The abstraction of blood may be effected by scarification, puncture, incision, leeching, and cupping. The fluid is sometimes taken from a vein or an artery; the operation, in the former case, constituting what is termed venesection, in the latter, arteriotomy.

1. *Scarification.*—Scarification is performed with the lancet, scalpel, or bistoury, passed lightly and rapidly over the inflamed surface, so as to divide the engorged vessels, and thus afford them an opportunity of freeing themselves of their contents. It is employed chiefly in conjunctivitis, tonsillitis, erysipelas, and irritable ulcers, and may be repeated once a day, or once every other day, according to the exigencies of the case, the bleeding being promoted by the liberal use of warm water. In irritable ulcers of the extremities as well as in other parts of the body, scarification is an exceedingly useful practice, which I have long pursued with great advantage. The proper mode of proceeding is to immerse the limb, previously constricted just below the knee, in a vessel of warm water, and then to make from four to eight vertical incisions over the sore, extending merely through the superficial portion of the true skin. In this manner I have repeatedly bled patients to syncope, making thus a most salutary impression both upon the part and system. In granular conjunctivitis, the eyelids, especially the upper, may often be scarified with the happiest effect; and in ophthalmia, attended with chemosis, deep incisions are generally practised to relieve engorgement and prevent strangulation of the vessels of the cornea. In tonsillitis, scarification nearly always greatly mitigates the symptoms; while in erysipelas, especially in the phlegmonous variety of that disease, it forms a most important element of the local treatment, nothing else being so well adapted to remove tension and prevent gangrene.

2. *Puncturing.*—Puncturing is performed very much with the same intention as scarification. It is particularly valuable in erysipelas, active œdema, boils, carbuncles, hemorrhoids, and affections of the tonsils, uvula, lymphatic glands, scrotum, prepuce, uterus, labia, and nymphæ, its beneficial effects depending upon the amount of drainage following the operation. The best instrument for performing the operation is a very narrow, sharp-pointed bistoury, thrust rapidly into the inflamed surface, to a depth varying from a line to half an inch, according to the degree of swelling of the affected parts, care being taken to avoid injuring important vessels and nerves. In the more severe forms of phlegmonous erysipelas, as many as fifty, seventy-five, or even a hundred punctures may sometimes be made with advantage.

3. *Leeching.*—Leeching is applicable to a great variety of affections, and is, perhaps, more frequently employed than any other mode of topical bleeding. The operation, however, is not without pain, and, unless properly performed, may even be followed by danger. Thus, in epidemic erysipelas, I have known it to give rise to an attack of this disease, which speedily destroyed the patient. Sometimes, again, leech-bites degenerate into bad sores, and produce much constitutional irritation. Ill effects are most likely to arise when the leeches are sickly, or when they are applied to persons of a nervous, irritable temperament. Hence, great caution should always be exercised in their selection, as well as in the manner of using them.

The best leeches are the Swiss, German, French, and Spanish, which generally take hold with great avidity, and draw each from half an ounce to six drachms of blood, including the flow after the animal drops off. The American leeches, although much larger than the European, bite reluctantly, and suck sluggishly, on which account they are rarely used. Moreover, the wound made by the foreign leech emits four times as much blood as that made by the native; a fact not to be lost sight of in ordering this kind

of bleeding. Whatever species be employed, the rule is to divest the part of hair and dirt, otherwise the animal, which is very fastidious in its tastes and habits, will either not take hold at all, or only after much coaxing. If, notwithstanding these precautions, it is not inclined to bite, a little blood should be smeared upon the surface, drawn from the part with a delicate needle, or from the operator's own finger, previously constricted with a tight cord, or the surface may be wet with sugared water or sweetened milk. Immersion of the animal for a few minutes in beer or ale will sometimes induce it to take hold when hardly anything else will. When the number of leeches to be applied is considerable, they should be confined in a tumbler, inverted upon the part, to prevent them from crawling about ; they must not be crowded too closely together, and they must, as a rule, be allowed to remain on until they drop off of their own accord, as they will be sure to do as soon as they have " taken their fill." Their forcible separation is not only productive of pain, but sometimes leaves a portion of the jaw in the little triangular wound made by its bite, which soon becomes inflamed and irritable in consequence. The bleeding is encouraged by sponging the surface well with warm water, and then covering it with a thickly-folded flannel cloth, wrung out of hot water, and frequently renewed, for a period varying from thirty minutes to two hours, or even longer, according to the desired effect. The blood having ceased to flow, the part is sprinkled with powdered starch, and covered with a dry cloth. If there is any disposition to bleed more, or longer, than is deemed proper, the bites are covered with a piece of dry tinder, which, especially if conjoined with a little pressure, generally soon puts a stop to the effusion.

The number of leeches to be applied at any one time varies from one to several dozens, according to the intensity of the morbid action, and the age and strength of the patient. In the adult from fifteen to twenty is a good average number ; in children under five years of age, from three to six. In infants the bite of a single foreign leech is sometimes followed by fatal depression. The extraordinary delicacy of the skin, and, consequently, the great depth of the bite, are reasons why leeching should be practised with more than common caution at this tender age.

There are certain localities where leeches are inadmissible. Thus, in the first place, the face, neck, and other parts habitually exposed are, if possible, avoided, because the bites of these animals are liable to be followed by disfiguring scars, particularly objectionable in the female. Secondly, they must not be applied to the eyelids, scrotum, prepuce, labia, and nymphæ, structures abounding in loose connective tissue, and therefore readily admitting of great infiltration of blood, as well as extensive discoloration. Thirdly, they must not be placed along the course of a superficial artery, large vein, or nervous trunk ; lest they should occasion serious hemorrhage and severe pain. Fourthly, care is taken to avoid the focus of an inflamed surface, as they might seriously aggravate the morbid action, if not induce gangrene. Fifthly, it is a rule not to apply these animals in the vicinity of specific ulcers, as chancroids and open buboes, for fear of inoculating their bites, and thus propagating the specific disease. Finally, leeches should never be used upon persons affected with the hemorrhagic diathesis.

A discharge of blood by leeches for a number of successive hours is sometimes very desirable, as soon as one set drops off another supplying its place. In violent ophthalmia, croup, peritonitis, erysipelas, and bubo, there is no mode of depletion so beneficial, or so likely to put a prompt and permanent stop to the disease, as this.

In leeching the uterus, vagina, ano-rectal outlet, the nose, and inside of the cheek, the animals must be confined in a glass or wire speculum, the opening in the instrument being held upon the part from which the blood is desired to be taken.

Serious, and, indeed, frightful hemorrhage sometimes follows a leech-bite. The occurrence is especially to be dreaded in children, in whom it occasionally produces fatal exhaustion, as I have myself witnessed in two instances. The best remedies are dried tinder, bound firmly upon the part, compresses wet with a saturated solution of alum or a solution of subsulphate of iron, the application of a thick layer of collodion, and cauterization with solid nitrate of silver, cut to a delicate point, and inserted into the little wound, previously well cleansed and dried. Pressing the glazed surface of a visiting card firmly upon the orifice sometimes answers the purpose. If these means prove abortive, the edges of the wound should be transfixed with a cambric needle, and approximated by ligature ; a procedure which seldom, if ever, fails.

When the natural leech is not at hand, a tolerable substitute may be found in the artificial leech of Baron Heurteloup, consisting of a small cylindrical drill, and of a glass exhausting-tube with an air-tight piston, worked with a screw. The incision may be carried to any depth, and, if the instrument be properly managed, several ounces of blood

may thus be drawn in a very short time.   The great points to be observed are to make a free opening, and to accommodate the screw-movement to the rate of bleeding, otherwise there will be a vacuum above the column of blood, thereby interfering with its flow.

4. *Cupping.*—Cupping is by no means so eligible a mode of bleeding as leeching, being more painful, less elegant, and not so generally applicable. It is, nevertheless, when properly executed, a valuable operation, particularly in the early and declining stages of inflammation. An incipient pleurisy, pneumonia, or articular inflammation is often promptly relieved by the application of half a dozen cups; but it is chiefly in the latter stages of acute disease, after the morbid action has been weakened by other remedies, and in chronic affections, that cupping asserts its true rank as an antiphlogistic agent. It is seldom, if ever, permissible in gastritis, peritonitis, and enteritis, on account of the great pain produced by the application of the scarificator. The operation, to be really serviceable, should be performed as near to the seat of the disease as practicable, care being taken not to open any large vessel, to prick any nervous trunk, or to wound any tendons. The surface selected for the application of the cups must be free from bony prominences, and, without being very soft, must have a good stratum of subcutaneous connective tissue, otherwise it will be impossible for the cups to maintain their hold, and extract a sufficient amount of blood. If the part is thickly covered with hair, it must previously be shaved.

Fig. 170.
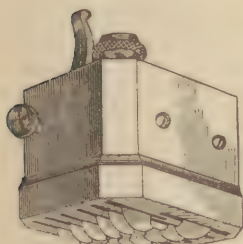
Scarificator.

The scarificator, fig. 170, usually employed for cutting the skin, is provided with eight, twelve, or sixteen little blades, moved by a common spring, and so arranged as to make a corresponding number of incisions, none of them being deep enough to extend entirely through the cutaneous tissue, lest the fatty matter, projecting into them, should fill up the little orifices, and thereby impede the flow of blood.   The cup is capable of holding from one to two ounces; it is bell-shaped, and is composed of glass, having a large mouth, with a stopcock at the other end, to adapt it to a syringe for exhausting the air, as in fig. 171.   When such an apparatus is not at hand, the ordinary cupping-glass may be used, or any still more simple contrivance, the air being rarified by inverting the vessel over the flame of a lamp, or by means of a little pellet of cotton, wet with alcohol, and set on fire in the glass.   In a few moments the skin rises and forms a red, conical swelling, which is now scarified, the cup being immediately replaced, and allowed to remain until the coagulum in its interior arrests the flow of blood, when it is carefully removed, to be again replaced as soon as the incisions have been freed from obstruction.   If the bleeding cease before the requisite supply has been obtained, the surface is cut crosswise, and the operation proceeded with as previously.   As much blood having been drawn as may be considered proper, the glasses are removed, and the parts covered with a soft cloth moistened with oil. The number of cups varies from one to a dozen, according to the desired effect.

Fig. 171.

Cupping apparatus.

The most elegant and convenient contrivance, by far, is one made of the body of the ordinary glass cup, surmounted by a cone of vulcanized India-rubber, as seen in fig. 172. In order to apply it, all that is necessary is to indent the top with the finger, the removal of which permits the part instantly to regain its former position, thus exhausting the air within, as it does with great force and efficiency.

Fig. 172.

Cupping-glass with Vulcanized India-rubber top.

Although cupping is generally a perfectly safe operation, instances have occurred in which it was followed by annoying, if not fatal, hemorrhage. Such a result is most likely to happen when a superficial artery, as, for instance, the temporal, has been penetrated, when the blood has lost its coagulability, as when there is some idiosyncrasy, or when the system has been exhausted by protracted disease, as typhoid fever, a severe wound or a compound fracture.   The treatment must be conducted upon the same principles as in bleeding from leech-bites.

5. *Venesection.*—Venesection is commonly regarded as so trivial, simple, and easy an operation, that it has rarely received the consideration and attention to which its in-

trinsic importance really entitles it. Everybody, no matter whether he has any knowledge of the anatomy of the parts involved in the operation, or the slightest skill in the use of instruments, is supposed to be capable of performing it, and it is, therefore, often done in the most bungling manner, entailing much suffering, if not loss of limb and life, upon the patient, and great discredit, if not ruin, upon the practitioner. During the reign of the lancet accidents from its use were sufficiently common, and, for a time, I had quite my share of them, although, fortunately, not as the result of my own bad luck. Thus, in two cases I saw the patients perish from phlebitis; in five, I was obliged to tie the brachial artery at the bend of the arm; in several, great and protracted suffering ensued from the puncture of a nerve; and in three instances the arm was endangered by erysipelatous inflammation, followed by immense abscesses, and great impairment of the functions of the elbow, wrist, and finger joints. The character of the operator is sometimes seriously injured by these mishaps. It is related of Maréchal, who flourished in the reign of Louis XIV., and who was styled, by one of the poets of his day, the prince of surgeons, that he suffered greatly in his reputation for several years, on account of a fatal accident which followed the bleeding of a foreign nobleman.

A vein may be opened with a spring lancet, a thumb lancet, or a bistoury, according to the whim, fancy, or habit of the operator. I have myself been so long accustomed to the use of the first of these instruments, that I seldom employ any other. Experience has taught me that the operation, when done with the spring lancet, generally answers every purpose, as it respects the size and shape of the orifice, the safety of the parts, and the facility of manipulation, while it is incomparably less painful than when it is performed with the thumb lancet or bistoury. These are, I think, important desiderata, which no unprejudiced practitioner can overlook. No one who has himself been bled with these different instruments can hesitate about his future choice. I know that the thumb lancet is generally considered as a more scientific instrument than the spring lancet; it is certainly more simple, and, perhaps, also more easily kept in order; but these advantages do not, in my judgment, outweigh the disadvantages. Both these instruments are so well known that any description of them here would be superfluous. If a bistoury be used, one of very small size should be selected, somewhat like that employed in opening abscesses, described at page 437. It should be quite narrow in the blade, slightly spear-shaped at the extremity, and not more than half an inch long in the cutting part. Such an instrument, confined in a light handle, is more elegant than the ordinary thumb lancet, as well as more easily managed, and is decidedly more surgical and scientific; a circumstance so much insisted upon by some practitioners.

Whatever instrument be employed, it should be perfectly sharp, clean, and always well washed and wiped both before and after the operation, for it is only by observing these precautions that it can be kept in proper order, and that the surgeon can hope to avoid undue irritation and other mischief in the wounded structures. The use of a foul lancet has often been a cause of death.

Bleeding at the Bend of the Arm.—In bleeding at the bend of the arm, the best plan is to select the largest and most superficial vein, having previously ascertained that the brachial artery is not in danger of being wounded, as it might be when it lies just behind the vessel, or close along its side. When the artery separates high up, one of its branches generally passes immediately under the skin, and might thus be easily opened by an incautious operator. As to the superficial nerves, it is seldom possible altogether to avoid them, whatever vein may be selected; nor is this a matter of much moment, provided they are completely divided, and not merely pricked. The veins of the bend of the arm, with the accompanying nerves, are well seen in fig. 173.

In order to distend the vein, a fillet, a yard long by an inch in width, is tied firmly round the arm, about two inches and a half above the bend, the ends being secured with a slip knot. It must not be drawn so tightly as to interrupt the circulation in the brachial artery. The patient, extending his arm at a right angle with the trunk, in a state midway between pronation and supination, grasps a common cane, a yardstick, or any other suitable object, holding the limb in an easy, gentle position. The surgeon, standing behind the limb, then pierces the vein, making the opening obliquely, and of sufficient size to furnish a free stream. The adjoining sketch affords a better idea of the manner of holding the lancet than the most elaborate description could. The surgeon uses whatever hand may be most convenient: the vein is thoroughly steadied with the finger previously to making the incision, and care is taken that the orifices of the skin and the vessel do not afterwards lose their parallelism, lest the flow of blood should thereby be seriously embarrassed, or the fluid escape extensively into the subcutaneous connective tis-

sue. Should the latter accident occur, the fillet must be immediately removed, and the requisite abstraction effected from another vein. Sometimes the blood flows sluggishly, although the opening may be quite capacious and unobstructed. When this is the case, the patient should alternately flex and extend his fingers, so as to cause energetic contraction of the muscles of the forearm, which often powerfully promotes the bleeding; or, instead of this, or along with it, the operator rubs the limb from below upwards, although

Fig. 173.   Fig. 174.

such a procedure is seldom attended with much advantage. Sometimes the flow of blood is interrupted by the protrusion of a pellet of fat into the orifice of the vein, the timidity of the patient, or the occurrence of partial syncope.

When the spring lancet is used, the instrument is held between the thumb and first two fingers, the heel being raised a little from the surface, while the fleam is gently pressed upon the distended vein. The opening is effected in the same oblique manner as in bleeding with the thumb lancet.

The blood should always be received into a large basin held by an assistant, and special pains should be taken not to soil the patient's body- or bedclothes. When the object is to make a strong and permanent impression, the blood is taken from a large orifice, the patient being in the semierect posture. If he is very plethoric, and the object is to abstract a very large quantity of blood without occasioning syncope, the recumbent posture is selected. When the requisite amount of fluid has been discharged, the fillet is untied, and the arm is wiped with a towel wet at one end, the edges of the orifice being carefully approximated and covered with a small, thick compress, supported by a narrow roller passed round the elbow in the form of the figure 8. The arm is maintained at rest in a sling forty-eight hours, as premature motion might be productive of suppuration and erysipelas.

When blood cannot be obtained from the arm, it may, in case of urgency, be drawn from a vein on the back of the hand, from the cephalic vein as it runs along the groove between the deltoid and pectoral muscles, or from the external jugular vein. Bleeding in the veins of the leg and foot is now seldom practised, although it was at one time very common, especially among the lower classes of people.

The *accidents* that are liable to attend and follow this operation are, infiltration of blood into the subcutaneous connective tissue, inflammation of the edges of the wound and of the surrounding parts, phlebitis, angeioleucitis, puncture of the nerves, and wound of the brachial artery.

a. An *extravasation* of blood beneath the skin is one of the most common effects of this operation, and may be caused by various circumstances, as the smallness of the incision, the want of parallelism between the outer and inner openings, the great laxity of the connective tissue, transfixion of the vein, and the accidental occlusion of the wound by the interposition of adipose substance. The extravasation may be diffused or circumscribed, forming in the one case an ecchymosis, in the other a thrombus. In the former variety, the blood sometimes extends along the anterior part of the limb, nearly as high up, on the one hand, as the axilla, and, on the other, as far down as the inferior third of the forearm; imparting to the skin, at first, a dark, purplish hue, and afterwards, as the fluid is absorbed, a mottled, greenish, yellowish, or sallow appearance. A thrombus is a collection of blood immediately around the wound, from the volume of a marble to that of a pullet's egg, irregularly rounded at the base, and usually somewhat pointed at the top. Both these accidents are most liable to occur in thin, emaciated subjects, in bleeding at the basilic vein, and they should always be promptly remedied by attention to the exciting cause; or, when this is impracticable, the bandage should immediately be removed, and

the requisite quantity of blood taken from another vessel. The latter procedure is particularly indicated when the infiltration is dependent upon transfixion of the vein, the presence of a pellet of fat, or unusual laxity of the connective tissue. Defective parallelism may sometimes be corrected by changing the position of the limb; and a small orifice may be enlarged by the reintroduction of the instrument. Under no circumstances, whatever may be the nature of the difficulty, should the operator attempt to promote the flow of blood by the use of the probe, inasmuch as this would inevitably be followed by mischief.

When the extravasation is slight, it will usually disappear spontaneously in a very few days; when considerable, recourse must be had to refrigerant and sorbefacient applications, particularly a strong solution of the hydrochlorate of ammonia, alcohol, and water, and, in the latter stages, camphorated lotions, soap liniment, and similar articles. If matter form, or if the parts become angry and inflamed, leeches, blisters, and cataplasms may be necessary, with incisions to evacuate the effused blood and other fluids.

β. The edges of the wound, made in this operation, are sometimes seized with *inflammation* and suppuration; or, instead of this, a small abscess, conical, circumscribed, and very painful, forms immediately around it. Occasionally, especially in feeble, sickly, and intemperate persons, the morbid action assumes an erysipelatous type. The most common causes of these mishaps are a dull, rusty, or foul lancet, imperfect apposition of the lips of the wound, improper tightness of the dressings, premature use of the parts, and, above all, the contact of the fingers, after the removal of the fillet, for the purpose of preventing the further escape of blood. The latter circumstance has not received sufficient attention. The fingers of the operator, without his being aware of the fact, are often covered with perspiration and other matter, which, when brought in contact with the edges of the incision, are almost certain to irritate and inflame them. The only safe plan is never to touch the wound for any purpose, but, after the fillet is removed, to approximate its lips with a clean compress, made of old muslin, and confined by an appropriate bandage. If, despite proper precautions, inflammation and suppuration arise, the usual antiphlogistic means must at once be employed.

γ. *Phlebitis*, to a slight extent, is probably of much more frequent occurrence after this operation than is generally imagined, while the severer forms of the disease, those, which, properly speaking, constitute pyemia, are comparatively rare. It may be induced by various circumstances, of which the employment of a foul lancet is, perhaps, the most common. In one instance I knew it to be caused by probing the wound, under the supposition that it contained a piece of the fleam of a spring lancet, broken off in the operation, performed by a young and inexperienced practitioner. The patient, a man, thirty-six years of age, was laboring under bilious fever, from which, but for this unfortunate event, he would probably have recovered; phlebitis, however, set in, and in less than a week he died. In another fatal instance, the vein was opened with a thumb lancet, and the disastrous effects arose without any evident cause, the patient, a stout negress, being at the time affected with inflammation of the wrist-joint.

The symptoms of this form of phlebitis do not require special notice, inasmuch as they do not differ from those of phlebitis in general. The attack is commonly ushered in by pain, stiffness, and swelling of the affected part, and by rigors, alternating with flushes of heat, and followed by copious perspiration. The inflamed vein is gradually converted into a hard, rigid cord, the morbid action steadily pursuing its course towards the heart, its progress being indicated by a reddish blush of the skin. In some instances, metastatic abscesses form in different parts of the body, particularly in the subcutaneous connective tissue around the larger joints, if not also in the joints themselves. The symptoms soon assume a typhoid character, the mind wanders, great soreness is felt in the muscles and articulations, the patient complains of excessive prostration, and death generally follows in from six to eight days from the commencement of the invasion.

The treatment consists in the application of leeches, blisters, and iodine along the course of the vein, and the exhibition of calomel and opium, with the twofold object of bringing the system promptly under the influence of mercury, and allaying pain and promoting sleep. Abstraction of blood, except by leeches, is always prejudicial. Purgatives and antimony must always be avoided. If abscesses form, they must be promptly and thoroughly opened. Diffusible stimulants, tonics, milk punch, and beef essence, with an abundance of fresh air, are the proper remedies, in the event of great and rapid exhaustion. Should recovery take place, sorbefacients will be required to promote the removal of effused fluids in and around the diseased vein, which, however, despite our treatment, usually remains impervious.

δ. *Angeioleucitis* is usually produced by the same causes as phlebitis, which it also resembles in its nature, progress, and symptoms. The morbid action, still more than in the latter disease, has a tendency to extend up the limb, the course of the affected lymphatics being indicated by reddish lines, very narrow, and exquisitively tender on pressure. The disease, which generally occurs in a mild form, requires the same treatment as phlebitis, with which it is occasionally associated.

ε. Puncture of a *nerve*, whether it be a trunk of considerable size, or a mere thread-like filament, may prove to be a very serious accident. The nature of the injury is always indicated by a peculiar, stinging, burning, or pricking pain, and a sense of numbness, creeping, or formication in the distal portion of the limb. When very severe, the local distress may be attended with a certain degree of shock and a tendency to syncope, which, however, generally soon pass off. Very unpleasant secondary symptoms sometimes succeed this accident, at a period varying from several weeks to several months. One of the most common and distressing of these is neuralgia, often occurring in regular paroxysms, as neuralgia from ordinary causes in other situations. The disease is then liable to be exceedingly severe and obstinate, often resisting, for months, and even years, the best directed efforts at relief. In the cases which have fallen under my observation, it has usually been accompanied, especially in its earlier stages, with considerable swelling, numbness, and stiffness in the distal portion of the limb, together with exquisite tenderness on pressure along the course of the affected nerve. I have never known tetanus to follow this accident, but such an occurrence is not impossible, particularly in a person of a nervous, irritable temperament, laboring, at the time of the injury, under disorder of the digestive organs.

The milder effects of this injury usually pass off in a very short time without any remedial measures, simply by attention to rest and elevation of the limb. When the case is obstinate, recourse is had to anodyne and astringent fomentations, the application of iodine and even blisters, purgatives, light diet, and other antiphlogistic means. The bandage is often of great service, especially when there is considerable swelling. When the pain is of a neuralgic character, quinine, strychnia, and arsenious acid will be indicated, and, if given persistently, and in suitable quantities, will be of immense benefit. When the suffering is extremely violent and intractable, the best remedy is division of the affected nerve, as near as possible to the seat of the injury, by the subcutaneous method; or, when this is impracticable, by exposing the nerve first, and then severing it. Occasionally it becomes necessary to remove a small portion of the affected nerve, especially if, as now and then happens, it is expanded into a little nodule, or is exquisitely tender and sensitive on pressure.

ζ. A wound of the *brachial artery*, always a very serious accident, may be very slight, amounting to a mere puncture, or it may be several lines, half an inch, or even an inch in extent, as in a case under my observation some years ago. The direction of the wound may be oblique, longitudinal, or transverse, according to the manner in which the instrument is held at the time of the operation. Occasionally the artery, instead of being pierced or stabbed, as it ordinarily is, is transfixed; a circumstance which always seriously complicates the case.

The immediate effect of this accident, which is always denoted by the impetuous saltatory nature of the stream, and by its scarlet complexion, is to send the blood into the connective tissue, forming a soft, dark-colored, circumscribed tumor, or a diffused swelling, which may involve the greater portion of the anterior surface of the limb from the middle of the forearm to within a short distance of the axilla. Such an occurrence is always formidable in its character, alarming to the patient, embarrassing to the surgeon, and liable to be followed by the worst consequences.

The treatment of this accident is by systematic compression, when the opening is small, and by ligation of each extremity of the artery, when it is large.

Bleeding at the Jugular Vein.—The opening of this vessel, fig. 175, may become necessary in cases of great urgency, as in sudden and severe apoplectic seizures, and in violent inflammation of the brain, eye, and ear. In general, however, it may be dispensed with even here, the requisite quantity of blood being more easily obtainable at the bend of the arm. The patient's head being firmly supported upon a pillow, and inclined a little upwards and towards the opposite side, the vein is made to raise by pressure with the finger or thumb, applied immediately above the clavicle. The lancet is then introduced about midway between this point and the jaw, and carried obliquely upwards and outwards, so as to divide the fibres of the platysma myoid muscle crosswise instead of vertically, as this affords the edges of the wound a much better chance of retracting. A pasteboard

trough or glass tube may be used to guide the blood into the receiver. The pressure below the orifice should not be removed until the operation is completed, lest air should pass

Fig. 175.

Bleeding at the Jugular Vein.

into the vein, and thus destroy life. The requisite quantity of blood having been drawn, the wound is covered with a few strips of adhesive plaster, aided, if need be, by a compress and bandage carried round the neck and shoulders.

Bleeding at this vein in the child is peculiarly embarrassing. The best mode of performing it is to place the patient's head between the surgeon's knees, the body and limbs being firmly held by the nurse, otherwise the blood will not only flow very imperfectly, but spirt over every one present. The vein, compressed against the first rib, should be opened quite freely. A compress and a few adhesive strips, lightly applied, constitute the proper dressing.

Bleeding at this vessel in the child is not practised sufficiently often. It is particularly applicable to violent affections of the brain, larynx, and lungs, and might, in most cases, advantageously take the place of venesection at the bend of the arm, the veins of which are generally opened with great difficulty, especially in very fat subjects.

Bleeding at the Ranine Vein.—Bleeding at this vessel was formerly quite fashionable, and is no doubt entirely too much neglected at the present day. It is said to have been performed by the elder Mestivier, during a practice of twenty years, nearly fifteen hundred times, and generally with very gratifying results. It is alluded to by many of the older writers, but was in great measure forgotten until attention was recalled to it by Cruveilhier. The operation has been found particularly serviceable in acute affections of the tongue and salivary glands, the tonsils, palate, fauces, larynx, and lymphatic glands about the jaws and throat. The two veins may be opened in immediate succession, or, if the case present no special urgency, one alone may be punctured; and, as they lie immediately beneath the transparent mucous membrane, at the side of the frenum, the operation may always be performed without any risk to the ranine arteries. The incision may be transverse, and extend completely across the vessel, as suggested by Aran, or it may be made in the direction of its length, which, perhaps, is generally preferable, as the blood will then issue in a larger stream and for a longer time. In this way several ounces of fluid may usually be readily obtained. The bleeding may, if necessary, be encouraged by rinsing the mouth frequently with warm water. If the discharge is more copious than is desirable, a lump of ice laid under the tongue will generally promptly arrest it.

The patient, during the operation, should sit upon a chair or the edge of the bed, and the tongue should be gently pressed against the incisors of the upper jaw. In children,

Fig. 176.

Bleeding at the Temporal Artery.

it will generally be necessary to draw the tip of the organ out of the mouth with a dry cloth.

I have thus briefly described this operation in the belief that it may often be advantageously practised in the class of cases above alluded to. It certainly deserves to be revived.

6. *Arteriotomy.*—This operation is occasionally necessary in urgent affections of the brain and eye, and is usually performed upon the anterior branch of the temporal artery, a vessel which possesses the twofold advantage of being very superficial, and at the same time resting upon a resisting bone. Feeling for the artery, in front of the temple, the surgeon employs firm pressure upon it with the finger, so as to steady it properly, while he makes the requisite incision with a small bistoury, carried obliquely across the vessel, care being taken to cut the parts in such a manner as to admit of a full and rapid stream. A sufficient amount of blood having flowed, the artery is completely divided, in order that its extremities may retract, and thus prevent the formation of an aneurism, an effect of which I have seen several examples. A small, thick

compress is then placed upon the wound and firmly secured by a bandage, carried round the head in the manner represented in fig. 176.

SECT. VII.—TRANSFUSION OF BLOOD.

Transfusion of blood from the veins of one person into those of another is imperatively demanded when a patient is rapidly sinking from hemorrhage, whether the result of disease, accident, or operation. It has hitherto been more particularly employed in profuse and exhausting flooding, and there are numerous cases upon record where it was thus instrumental in preserving life. In such an event it is the last resource of the obstetrician, and no one should hesitate to perform it, even although the woman should literally be in the act of dying, or when, to borrow the language of an eminent writer, " the vital spirit is fluttering with tremulous delay upon the lip." Instead of blood, saline fluid is sometimes transfused, as in attacks of Asiatic cholera, attended with excessive prostration, consequent upon the rice-watery discharges from the bowels effectually draining the vessels of their serous contents. The intravenous injection of milk, to which attention has been especially directed by T. Gaillard Thomas, is liable to be followed by fat embolism, and should, therefore, only be resorted to when blood cannot be obtained from a healthy person.

The operation in question requires great care and skill for its successful execution. The chief danger to be guarded against is the entrance of air into the vein, the smallest quantity of which might prove destructive. As ordinarily performed, it is necessary to have at hand, besides a lancet, a tumbler and a glass syringe, the latter being in complete working order. The person from whom the blood is taken must be in good health, and free from all constitutional taint. The arm being tied up, and the vein opened, the blood is allowed to fall into the tumbler as it stands in a basin of water, at a temperature of about 100°, lest the fluid should coagulate, and thus become unfit for use. As soon as about two ounces have been drawn, it is sucked up into the syringe, the nozzle of which is then inserted into the patient's vein, the median basilic, for example, previously exposed by an incision at least an inch in length, and raised upon a probe. In this manner one portion after another is cautiously thrown in until from twelve to sixteen ounces have been transfused, a quantity which it will seldom be judicious to exceed. Should the pulse flag during the operation, or convulsive tremors arise, the proceeding must immediately be suspended, as it is an evidence that injury instead of benefit is accruing.

A great number of contrivances have been devised for imparting to this operation a more scientific character than when it is performed with the ordinary syringe. The method, however, here described will generally be found to answer every purpose, combining, as it does, simplicity with convenience and safety.

When greater nicety is aimed at, the apparatus represented in fig. 177, and constructed, at my suggestion, by Mr. Gemrig, may be used. It consists of a small cupping-glass and

Fig. 177.
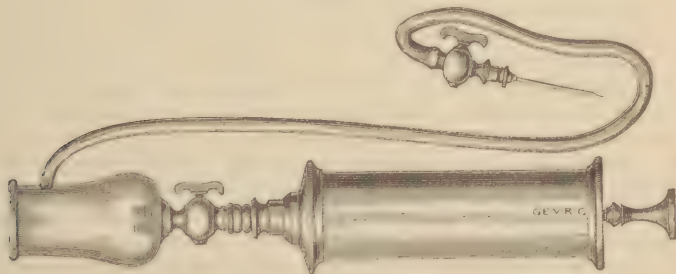
Author's Transfusing Apparatus.

syringe, with a gum-elastic tube, about eighteen inches long, having a stopcock at its distal extremity, which is surmounted with a nozzle cut off obliquely, like the barrel of a pen. The patient's vein having been exposed by an incision and freely opened, the nozzle is inserted into it, and securely held by an assistant. A vein is then punctured in a healthy person's arm, but the blood is restrained from flowing by the pressure of the finger applied some distance below, until the cup has been placed over the orifice and exhausted

of air by means of the syringe. As soon as this has been done, the stopcock is turned, so as to permit the fluid to pass readily from one vessel into the other.

Professor Hueter, of Greifswald, is an advocate of arterial transfusion, as he is convinced that in this method the blood is conveyed to the heart more slowly and equably than in venous transfusion, in which the sudden disturbance of the circulation has occasionally been the cause of death. Another advantage possessed by arterial transfusion is that if a small quantity of air gains admission into the current of blood, it does no harm, but is absorbed, at the same time that the dangers of phlebitis are thus avoided.

The radial artery above the wrist, or the posterior tibial under the malleolus, should be isolated to the extent of about an inch, and be surrounded by four ligatures, one of which is intended as a reserve ligature in case of accident to the others. The thread nearest the heart is first tied, and the syringe having been filled with blood, the peripheral ligature is somewhat tightened, to cut off the collateral supply of blood. At this moment the artery is divided through about half of its caliber with the scissors, and into the gaping wound the point of the syringe is inserted and secured by the third ligature. The second thread being then loosened, the piston of the syringe is put into action, and when the injection is completed, the thread is permanently tied as an ordinary ligature. The artery itself is divided close to the central and peripheral threads, and the portion attached to the canula of the syringe removed with it.

The transfusion of defibrinated blood into the peritoneal cavity for the relief of various affections has within the last few years been practised by a number of physicians, attention having originally been called to it by Ponfick. The operation, which should be performed under antiseptic precautions, is easy of execution, and generally devoid of danger. The only instruments required are an ordinary trocar connected with an elastic tube provided with a glass funnel, through which the defibrinated blood is thrown through the linea alba into the abdomen. Anemia, whether caused by loss of blood or protracted disease, as pulmonary phthisis, carcinoma, syphilis, or typhoid fever, is the disease mainly demanding, and likely to be benefited by, this mode of transfusion.

SECT. VIII.—HYPODERMIC INJECTIONS.

To Dr. Alexander Wood, of Edinburgh, the profession is mainly indebted for having utilized, if not actually originated, the hypodermic method of treatment, now so widely and so successfully employed in this and other countries. Its great certainty renders it a most valuable resource in many cases and forms of disease that could hardly be reached in any other way, while the effect of the remedies thus employed is far more rapid and powerful than when the same articles are administered by the mouth or the rectum.

The medicines that are most commonly used in this way are anodynes; but they need not necessarily be of this character, as various other agents may be equally successfully injected. Arsenic, strychnia, quinine, atropia, duboisia, aconite, belladonna, and kindred articles are daily thrown under the skin, and the list of remedies thus introduced into the system will no doubt be eventually very much extended. Subcutaneous injections of quinine have been very successfully employed in numerous cases of intermittent fever, a solution of five grains thus administered being fully as efficacious as five or six times that quantity given in the usual manner, at the same time that relapses are much less frequent. Arsenic has been similarly employed. In the nocturnal incontinence of urine of children few remedies are so efficacious as subcutaneous injections of belladonna. Morphia introduced under the skin generally dispels the most agonizing pain of every description within a few minutes. Excessive gastric irritability is usually promptly allayed by this method of medication; and I know of no remedy that so speedily and effectually relieves the intolerable anguish caused by the twitching of the muscles in fractures, dislocations, amputations, resections, gunshot wounds, and inflammation of the joints, especially coxalgia. Spasm of the eye after the operation for cataract and artificial pupil generally yields in a peculiarly happy manner to morphia employed in this way. Of late the hypodermic injection of bichloride of mercury has met with a good deal of favor as a remedy in the treatment of constitutional syphilis.

In using any medicine hypodermically, it is of the utmost importance to remember that the quantity required is much less than when the same article is given by the stomach or the rectum. Thus, even when a patient is in great agony, a quarter of a grain of morphia may usually be considered as a full dose, whereas double that quantity might be required if administered in the ordinary manner, and so with all other agents

whatever. Repetition may be safely effected several times in the twenty-four hours, or, in urgent cases, as when there is intense pain, in rapid succession.

The operation is performed with a portable syringe, fig. 178, capable of holding about one drachm of fluid, and furnished with a slender, delicate nozzle, bevelled off obliquely to a very sharp point. Some practitioners prefer a graduated instrument, but such a contrivance possesses no advantage whatever over the ordinary one. The best hypodermic syringe now in use, one least liable to get out of order, is that devised by Dr. Dowler, of Brooklyn, and described in the New York Medical Record for 1879. In performing the operation, a fold of skin, pinched up with the thumb and forefinger, is pierced at the base with the sharp point of the nozzle, which is then pushed on into the connective substance beneath, followed by the medicated fluid. The moment the instrument is withdrawn a finger is placed upon the puncture, while with another finger the fluid is pressed about until the elevation produced by it has been completely effaced, as the object is to promote its speedy absorption by bringing it into contact with as large an amount of tissue as possible. The medicine, whatever it may be, is mixed with nearly a drachm of cool water, and great care is taken that there is no air introduced along with it. It is not at all important that the place selected for the operation should be near the seat of the pain or of the disease for which it is performed; the most convenient points are the back of the arm and the corresponding part of the forearm, where there are no large veins, which must always be avoided, lest the medicine, passing directly into the circulation, should endanger life by the rapidity and violence of its action. For the same reason, if a very potent remedy be used, the injection should be performed very slowly, so that, if unpleasant symptoms arise, the operation may at once be stopped, or the fluid be even sucked out.

Fig. 178.
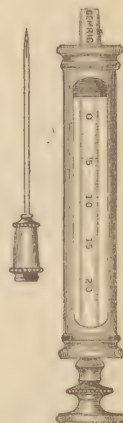
Hypodermic
Syringe.

Hypodermic injections are not always, so far as the tissues where they are made are concerned, wholly harmless, especially when they contain irritating substances. A number of cases of tetanus, induced by hypodermic injections of quinine, dissolved in water with the aid of a little aromatic sulphuric acid, for the cure of intermittent fever, have been reported; and instances in which the puncture made in the operation was followed by erysipelas, abscesses, painful ulcers, and other distressing local effects have been witnessed by different observers. Hard nodules sometimes form, giving the surface a rough tuberculated appearance; and cases have been reported in which the puncture gave rise to fatal pyemia.

SECT. IX.—VACCINATION.

The surgery of vaccination is very simple. It may be performed either with lymph removed between the sixth and ninth day, or, what answers nearly equally well, with the dried scab rubbed upon a plate of glass, with tepid water, until it is of a thin consistence, and of a very pale milky hue. The matter is taken up with the point of a sharp, narrow lancet, represented in fig. 179, a tenotomy knife, or a common needle, and inserted into the skin on the outer surface of the arm, just below the deltoid muscle, or on the outer and upper part of the leg at a suitable distance from the knee, at two spots, each about the diameter of a three-cent piece, and sufficiently far apart to prevent them from running together during the height of the resulting inflammation. The impregnation may be effected by a number of little punctures, by three or four superficial incisions, or, simply, by a slight abrasion of the epidermis. Whatever method be adopted, no blood should be drawn, as it might wash away the vaccine matter. When the operation is performed with lymph taken up on bits of ivory, a procedure which some practitioners prefer to any other, the points should be held for a few seconds in the steam of hot water, and then rubbed upon the raw surface.

Fig. 179.

Vaccine Lancet.

The wound, on the third day after a successful operation, is found to be slightly inflamed and elevated; and on the fifth day a characteristic vesicle appears, of a beautiful pearl-colored aspect, circular or oval in shape, and occupied by a drop of thin, limpid fluid. On the eighth day the vesicle is in its greatest perfection; it is now somewhat of a yellowish hue, distinctly cellulated in structure, very prominent, slightly umbilicated at the centre, and surrounded by a circular areola, the skin around being inflamed, tense,

and painful. Occasionally considerable swelling of the glands of the axilla exists. The constitution is now thoroughly implicated, and, as a consequence, the patient is feverish and restless. On the eleventh day the areola begins to fade, and the vesicle, which usually spontaneously bursts, gradually dries up into a hard, brownish, circular scab, which, dropping off from the eighteenth to the twenty-first day, leaves behind it a small, rounded, pitted, and indelible cicatrice, attesting the success of the operation.

Vaccination may be performed as early as the sixth week after birth, and at all periods of life subsequently. If the child is sickly, the general health should previously be amended, particularly if there be any eruptive disease. Some persons evince the most remarkable insusceptibility to the influence of the vaccine virus. I have seen a number of cases in which the operation was performed upwards of twenty times before it finally succeeded. Healthy children afford the best lymph, and the matter of primary is more energetic than that of secondary vaccination.

Lymph taken from the cow is now commonly preferred ; it is usually collected upon the end of a quill or a piece of ivory, and is softened with cold water immediately before it is inserted or rubbed upon the surface. Six or eight superficial incisions merely carried through the epidermis in a vertical direction are generally quite sufficient. Bleeding must be prevented. The lymph must be kept in a dry place.

The bad effects of the operation are, 1st, too much local action, the inflammation sometimes assuming an erysipelatous character ; 2dly, severe inflammation of the axillary glands ; 3dly, ulceration, or even gangrene, at the seat of the vesicle, leaving a sore which is occasionally very tedious in healing ; 4thly, a lichenous or roseolar eruption, attended with distressing itching, and often considerable swelling ; and 5thly, an appearance of vesicles upon the general surface, resembling those of varicella, or even those of genuine cowpox. The regular development of vaccinia is sometimes retarded by the preoccupation of the system by other affections, as measles and scarlatina.

It is impossible to exercise too much care in the selection of vaccine virus. To a want of this precaution may be ascribed most of the bad effects that follow the operation. A number of well-authenticated cases have been recorded during the last twenty years in which it gave rise to syphilis in its very worst forms.

The effects of vaccination are sometimes completely lost, in the proportion, probably, of about forty persons in one thousand. It is for this reason that the operation should be occasionally repeated.

SECT. X.—COUNTERIRRITATION.

Counterirritation may, as stated elsewhere, be established in various ways, as by rubefacients, vesicants, and dry cupping ; but when the object is to make a deep and protracted impression, the means usually selected are the permanent blister, the seton, and the issue. Sometimes the moxa and acupuncturation are employed.

1. *Rubefacients.*—A rubefacient effect, or temporary irritation of the skin, may readily be produced by a great variety of articles, as mustard, ammoniated liniments or unguents, spirits of turpentine, chloroform, hot water, and the hot iron. The latter, in the form of the objective cautery, as the French term it, consists in passing a piece of iron, heated perfectly white, rapidly over the surface at a distance of three to five inches. The skin becomes almost instantly red, and if the application be continued for a few minutes, vesication follows.

Mustard is generally applied in the form of mustard-paper, kept for ready use by the apothecary, and cut into suitable strips as it is needed. A mustard plaster may be made of mustard flour, mixed with water at a temperature of $90°$ to $100°$. If the water is too hot, it will coagulate the albumen ; if too cold it will prevent the disengagement of the oil upon which the irritating properties of the mustard depend. As more or less of the mustard is liable to adhere to the skin, the best plan always is to interpose a layer of gauze, or very thin muslin, wrung out of warm water. The time during which the application should be continued must vary, on an average, from ten to twenty minutes, according to the effect desired. Great care must be exercised in the use of sinapisms in children and in persons generally of very delicate skin, as well as in patients worn out by disease and intemperance, otherwise serious mischief may ensue. The smarting, burning pain which so often follows their application is commonly promptly relieved by lead-water, olive oil, or iced water.

A very useful and speedy rubefacient action may be produced by means of Dr. Corri-

gan's button cautery, fig. 180, heated in the flame of a spirit lamp until the forefinger, resting upon the shank of the instrument near the disk, begins to feel uncomfortably hot, the period usually required not exceeding a quarter of a minute. As soon as it is ready, it is applied as quickly as possible, the skin being tipped successively, at intervals of half an inch, over the whole of the affected part, which soon assumes a bright red appearance, and becomes the seat of a glowing sensation. The disk of the instrument is half an inch in diameter by three lines in thickness, with a flat surface, and a thick, iron-wire shank, two inches in length, and inserted in a small wooden handle.

Fig. 180.

Very efficient counterirritation may be produced by the actual cautery, heated to a white heat, and drawn lightly, but rapidly over the surface near the seat of the morbid action, at several points, for a distance of two to three, four, or even six inches. The application is immediately followed by reddish-brown welts, surrounded by a zone of scarlet, indicative of hyperemia. The pain is generally very insignificant, and there is seldom any vesication. The epidermis in a few days drops off in dry scales, leaving a slightly brownish stain, which soon disappears. The remedy is particularly valuable in neuralgia, gout, and rheumatism, and in superficial inflammations of the joints and other parts of the body. The cautery should be tipped with platinum, as it will thus preserve its smoothness, a desideratum of great importance.

2. *Dry Cupping.*—Dry cupping is occasionally employed, especially in chronic affections, in which it is often of great value. The air being exhausted, as in the more common operation, the cup is allowed to remain on the part for a period varying from thirty to forty-five minutes. At the end of this time it will generally be found that there is not only a marked afflux of blood, but likewise more or less vesication of the skin, objects which the practitioner should always endeavor to attain whenever he advises such an operation; for, unless it be performed efficiently, no benefit whatever will be likely to result from it.

Corrigan's Button Cautery.

Dry cupping is particularly serviceable in chronic disease of the brain and spinal cord, the thoracic and abdominal viscera, and the larger joints. The number of cups employed, and the repetition of the operation, must be regulated by the exigencies of the case.

An instance has been communicated to me in which this operation was followed by gangrene. The patient, a soldier, was affected with typhoid fever. Four dry cups were applied over the lower part of the spine, where they were retained for ten minutes. The surface soon began to assume a livid aspect, and the integument included in two of the cups sloughed out to the depth of a quarter of an inch, the others suffering in a less degree.

3. *Permanent Blisters.*—A permanent blister is made by letting the fly remain on the skin an unusual length of time, and then divesting the part of epidermis. It is capable of furnishing a free discharge of pus, which may often be maintained for a long time, either by the occasional reapplication of the fly, or by means of some irritating ointment, as the savin or mezereon; or, what I prefer, an ointment composed of an ounce of cosmoline and three to eight drops of nitric acid. Whatever article be used, the surface should be constantly protected with an emollient poultice or warm water-dressing, otherwise the sore will become excessively irritable, and cease to furnish the desired discharge. Whenever the secretion begins to slacken, a little of any of the unguents here mentioned may be applied to the sore to renew the morbid action. I have occasionally used the dilute fly ointment for this purpose, but having several times produced strangury with it, I have latterly abandoned it.

4. *Seton.*—A seton is a subcutaneous wound, holding a foreign body. It may be made with a bistoury, and a piece of gum-elastic tape, or in the absence of this, a narrow strip of muslin, conveyed beneath the skin by mean of an eyed probe or the seton needle, represented in fig. 181. The integument being pinched up, the instrument is pushed through the connective tissue, care being taken not to interfere with any muscular fibres, tendon, nerve, or vessel. The ends of the seton are tied long,

Fig. 181.
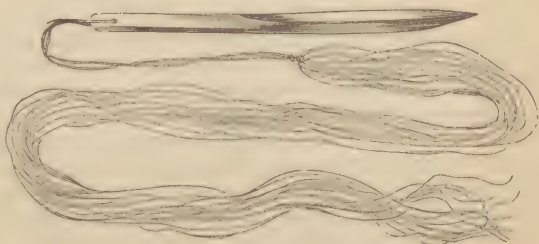
and held out of the way by a strip of adhesive plaster. The mode of introducing a seton with knife and probe is shown in fig. 182.

An emollient cataplasm is the most suitable dressing, both immediately after the operation and subsequently, during the sojourn of the foreign body. At the end of the second day the tape is drawn gently across the wound, a fresh portion taking its place, and this process is afterwards repeated as often as cleanliness and other circumstances may render

Fig. 182.
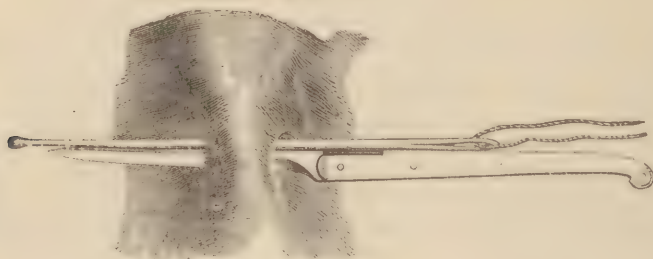
it necessary. If the discharge becomes deficient, recourse is had to some stimulating ointment; if offensive, to the chlorides. When the tape becomes soiled, a new one takes its place. Sometimes fungous granulations spring up at the orifices of the subcutaneous wound, causing much pain and inconvenience. The best remedy is excision, followed by nitrate of silver. The insertion of a seton is usually attended with little bleeding; but I recollect the case of an elderly gentleman, a patient of a late eminent practitioner, who nearly lost his life from this cause, the operation having been performed upon the nape of the neck. The blood seemed to have proceeded from a small artery among the cervical muscles, the instrument having penetrated too deeply. Great care should be exercised in the introduction of setons in front of the neck, as the operation has been followed, in several instances, by the admission of air into the veins and the speedy death of the patient.

A seton is, on the whole, a filthy, painful, and imperfect form of counterirritation, which it might, perhaps, be well to exclude altogether from practice, as its place may always be easily supplied by the issue.

The seton is sometimes employed as a means of obliterating cavities, as in hydrocele and the so-called housemaid's knee. Great care is necessary when it is thus used that it does not provoke too much inflammation. The filiform seton, as it is termed, generally consists of a single thread.

5. *Issue.*—An issue is an artificial ulcer, intended to furnish a discharge of pus. It is adapted to the same class of cases as the seton, but is more cleanly, less painful, and more convenient. Moreover, such a sore affords a good surface for the local application of morphia and other remedies, which may often be advantageously used, in this manner, for relieving pain, as well as for other purposes.

Issues may be made in various ways, as with the knife, the Vienna paste, the galvanic and actual cauteries. The first of these methods is not sufficiently efficient to justify its general employment; it is better adapted to the scalp than to any other region of the body, and may be advantageously used in diseases of the pericranium and of the brain and its meninges. An incision being made through the skin and connective tissue, from half an inch to an inch in length, its cavity is filled with some foreign body, as a pea, grain of corn, small pebble, piece of orris root, or, what is best of all, a solid glass bead, which soon produces a pyogenic action that may afterwards be increased, if necessary, by the use of some stimulating ointment. The substance is confined with a strip of adhesive plaster and a bandage, and is occasionally replaced by a fresh one, cleanliness being maintained in the usual way.

An excellent issue may be made with the *Vienna paste*, composed of equal parts of quicklime and hydrate of potassium, thoroughly triturated together, and preserved in a closely-corked vial until required for use. The requisite quantity is then put upon the bottom of a saucer, and converted into a thick paste with alcohol. A layer, about two lines in thickness and of the desired diameter, is put on the skin, and allowed to remain for eight, ten, or fifteen minutes, according as it is desired to make a slight or deep impression. The surface, which will be found to be of a pale drab color, is washed with vinegar and water, to neutralize the alkali, and covered with an emollient cataplasm, to promote the detachment of the slough, which usually happens in from five to eight days. Some pain

attends the operation, but this is soon over, and bears no comparison with the horrible distress produced by the application of hydrate of potassium alone; besides, the Vienna paste does not diffuse itself over the adjacent parts, and thus unnecessarily destroy the skin. The extent of the issue is regulated by the extent of the layer; one of the diameter of a twenty-five cent piece affording, when the sloughing is completed, a sore two or three times that size. The best permanent dressing is a poultice; the best promoter of discharge, some stimulating ointment, or the occasional use, for a few hours, of a small blister.

What is called the "London paste" is composed of equal parts of caustic sodium and unslaked lime, converted into a powder, and kept in a well-corked vial until required for use, when it is mixed with water instead of alcohol. Its advantage over the Vienna paste is that it is far less painful and much more manageable.

The most eligible issue of all, however, is that made with the *actual cautery*; it affords not only an abundant and protracted discharge, far beyond what follows the more ordinary issue, but, what is often a matter of no little consequence, it makes an impression both upon the part and system, which no other mode of counterirritation is capable of producing. On these accounts, this kind of issue should have a decided preference over every other in all protracted and obstinate cases of disease where the employment of revulsives is indicated, as in caries of the hip-joint, Pott's disease of the spine, and similar affections, in which its powers, as a topical remedy, are unequalled.

To perform the operation properly, the iron, heated to a white heat in a small charcoal furnace, should be pressed with some degree of firmness upon the spot selected for the issue until the skin is converted into a black eschar, the patient being fully under the influence of an anæsthetic. Care must be taken not to penetrate beyond the subcutaneous connective tissue. A cloth, wrung out of cold water, is immediately laid upon the part, and frequently renewed, for a few hours, when it is replaced by a poultice or warm water-dressing. The slough usually drops off in from five to eight days, leaving a sore, which, while it is easily kept clean, furnishes a free discharge, and may be kept open, with but little care, for an almost indefinite period. A cautery the size of a half-eagle will make an issue, after the separation of the eschar, of the diameter of a silver dollar. The instrument should be fully half an inch thick, otherwise it will not retain its heat sufficiently long.

6. *Moxa.*—The moxa is a soft, combustible substance held upon the skin, and suffered to burn down slowly, so as to produce a temporary irritant effect. It may be prepared from various articles, as agaric, hemp, cotton, rotten wood, the pith of the common sunflower, and the down of the artemisia chinensis; but the one which I usually prefer is soft patent lint, soaked in a strong solution of nitrate of potassium. When thoroughly dried, this is rolled up into tolerably firm, cylindrical cones, an inch and a half long by one inch in diameter. In applying them, they should be ignited at the top, and held upon the part intended to be cauterized with a pair of dressing forceps, a long hair-pin, or a porte-moxa, fig. 183; the surrounding surface is protected with a piece of wet linen perforated at the centre. When it is desired to hasten the combustion, a blowpipe may be employed, but in general this is unnecessary. Whatever substance is used, the heat can be so graduated as to produce any amount of irritation, from the slightest rubefaction to a superficial eschar. When the latter effect is desired, the moxa should remain on until it is wholly consumed; otherwise it may be removed as soon as the pain becomes somewhat severe; or, instead of placing the burning material in contact with the skin, it may be held at a little distance from it. The eschar is of a yellowish, gray, or dark color, and usually drops off in six or eight days. The pain produced by the operation may be promptly relieved by the application of ammonia, cold water, or pounded ice.

Fig. 183.

Porte-Moxa.

The moxa seems to act on the same principle as the objective cauterization, and the ammoniated counterirritants, already spoken of, and is a valuable agent in many chronic cases, when it is intended to produce a sudden impression upon the nerves of the affected part; it should always be applied as near as possible to the seat of the malady, and the effect should be sustained for weeks, or even months, by the repeated application of the agent. The diseases in which it seems to be most efficacious are amaurosis, neuralgia, nervous deafness, partial paralysis, coxalgia, and spinal irritation.

7. *Acupuncturation.*—Counterirritation may be effected also by acupuncturation. This consists in the insertion of very slender, well-polished, sharp-pointed, steel needles, figs. 184, 185, 186, from two to four inches in length, furnished with a metallic head, or

Figs. 184, 185, 186.

a head of sealing-wax. To prevent them from breaking, they should be rather soft and flexible. They are introduced into the affected part, previously stretched, by a gentle rotary motion, aided by slight pressure, and are suffered to remain from one to six hours, according to the effect they produce, or the object they are intended to fulfil. In some instances a period of ten minutes is sufficient; in others, they may be kept one or two days. They may be carried to a depth of several inches, but care must be taken not to transfix any important viscera, vessels, or nerves, though this has often been done without ceremony, and without any injurious results. The number of needles to be used varies from one to a dozen, according to the extent of the affected part and the sensibility of the patient. The operation rarely causes much pain, and is scarcely ever followed by any unpleasant symptoms. In most cases a slight blush, which subsides in a few hours, is observed around each puncture. In withdrawing the needles, which is sometimes effected with difficulty, owing to their having become oxidized, a movement of rotation should be given to them, at the same time that pressure is made upon the adjacent surface with the thumb and forefinger.

Acupuncture Needles.

Acupuncturation has been employed in a great variety of affections, as neuralgia, rheumatism, gout, sciatica, paralysis, cephalalgia, and epilepsy; recently it has been recommended in the treatment of aneurism, hydrocele, varicocele, and anasarca. Its advantages have been much overrated, and the practice, borrowed from the Chinese and Japanese, has fallen into disrepute.

SECT. XI.—SURGICAL APPLICATIONS OF ELECTRICITY.

Electricity is employed locally, as a surgical measure, under two forms, faradism, or the induced current, and galvanism, or the continuous current, and they are termed, according to their application, faradization and galvanization. The former finds its widest and most legitimate range of employment in the treatment of paralysis of movement, of muscular atrophy, and rheumatic contractions; while the calorific properties of galvanism are utilized principally for the removal and discussion of tumors, either as an actual cautery or as a catalytic agent.

Faradization, as an antiparalytic measure, acts by restoring the impaired or lost functions of the affected muscle, by throwing it into alternate contractions and expansions, through which a more abundant supply of arterial blood is transmitted to it, promoting its local circulation, and, consequently, augmenting its nutrition.

For the proper practice of local electrization, the choice of a good apparatus is of the first importance. Without entering into a description of electro-magnetic machines, or the properties which such instruments should possess, which would be out of place here, suffice it to say the requirements of the surgeon are fully met in the portable bisulphate of mercury battery of Gaiffe, of Paris, the induction apparatus of Stöhrer, of Dresden, or, in their absence, the instrument of Kidder, of New York. The larger zinco-carbon apparatus of Stöhrer, now thoroughly appreciated in this country, is preferable. It is constituted of two cells, which may be arranged as two pairs, or as a single pair of elements, and has a much greater range of power, and more thorough means of graduating the currents, than the smaller instrument. It does not require constant attention, and is always ready to act, since, by a simple contrivance, the elements can at once be immersed or removed from the exciting liquid, through which they retain their activity for a long time.

The electrodes, or reophores, vary in form, but they are commonly metallic cups or plates, fixed to insulating handles, the former of which contain a moist sponge, while the latter are covered with wet, soft leather. The handles are provided with clamps for the attachment of the conducting wires, through which they communicate with the poles of the battery. The diameter of the electrodes varies. When a large muscle is to be acted upon, it should range from one to three inches, while for the smaller ones, as the interosseous, and for indirect muscular faradization, the diameter need not exceed one-third of an inch, and they may even be conical in shape.

In cases of paralysis the muscles may be electrified in two different ways, either indirectly through the nerves which supply them, or directly by acting upon their proper tissue. The former method, known as extramuscular excitation, produces contraction of several muscles, or of all parts of a single muscle; while the latter, termed intramuscular

excitation, provokes contraction of only one muscle, or parts of one muscle, and requires a current of greater power. In either method, both the skin and electrodes should be kept thoroughly moistened with warm water, or salt water, not only that the current may traverse the skin and concentrate its power on the deeper tissues, but also to prevent the disagreeable sensations of heat and pricking which are sure to occur when the electrodes are dry. If it be desired to act directly upon a muscle, the reophores should be applied over their fleshy bellies, and never over the tendons, and be moved near together over all portions of the muscle corresponding to the surface. If the substance of the muscle be thick, the current must be more intense than when a thin muscle is operated upon, as a weak current only produces contraction of the superficial layers. The tension of the current should also be proportioned to the thickness of the tissues to be traversed, as is exemplified in fat persons, in whom a moderate current does not reach the muscle at all.

Nothing can be more simple than direct faradization of muscles; but the same remark does not apply to the extramuscular method, in which the current is directed to the points of entrance of the motor nerves, and which requires an exact knowledge of the entrance and exit of nerves, a knowledge, it need scarcely be added, that can only be attained by repeated dissections. The points of selection for the production of isolated contractions of muscles, however, have been mapped out by Professor Ziemssen, in his work entitled, Die Electricität in der Medicin, which may be consulted with advantage by those who desire specific information on indirect muscular faradization.

Localized faradization is a remedy of great value in the treatment of traumatic paralysis; and it has also been employed, by means of peculiar forms of electrodes, for atony and paralysis of the rectum, bladder, pharynx, œsophagus, and larynx, but without any striking results, excepting in cases of aphonia from loss of power in the vocal cords.

In treating paralysis by electricity, the fact should not be lost sight of that reliance is not to be placed upon faradization alone, since muscles which refuse to respond to induced currents, sometimes evince a remarkable degree of excitability by continuous galvanic currents. In such cases local galvanization is superior as a therapeutic agent to local faradization; but with return of mobility the excitability by the continuous current is commonly gradually lost, and that by induced currents gradually returns. Under these circumstances faradic currents must be employed.

Galvanization is chiefly applicable to the discussion and removal of certain tumors, diseases of the bloodvessels, chronic glandular swellings, firm inflammatory exudations in and around joints, serous effusions, the formation of issues, and the treatment of rebellious sinuses, fistules, and ulcers.

Fig. 187.
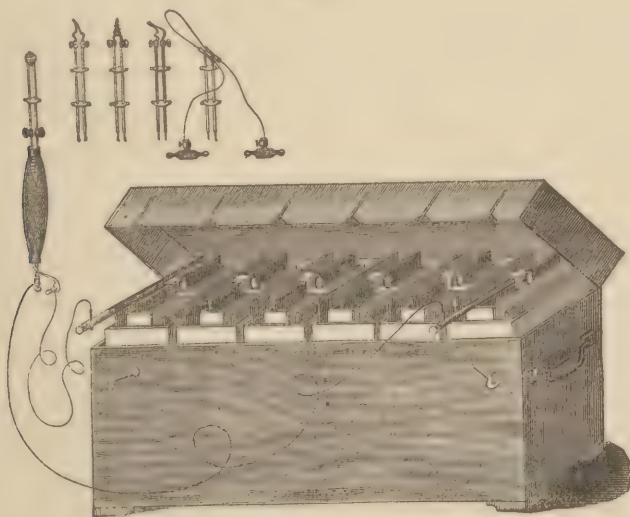
Bunsen's Battery with the Cauteries attached.

Of the many kinds of batteries used for the generation of the galvanic current, none is more excellent, less trying to the patience of the practitioner, and, in the end, more economical, than the portable battery, with lifting apparatus, of Stöhrer, consisting of

twenty-four, or more, pairs of elements. Bunsen's battery, fig. 187, with six cells, which contain essentially the same elements as those in Stöhrer's battery, will furnish the desired amount of heat for galvanic cauterization; but the elements are generally found to be too few for the electrolytic treatment of the firmer morbid growths. In the absence of these batteries, that invented by Daniell, with which every medical student is perfectly familiar, is the best, on account of its reliability, cleanliness, and cheapness. Fifteen cells, arranged in a case, will furnish a sufficient quantity of electricity for all surgical purposes. It should be taken apart every six or eight weeks in order that the zinc may be cleansed, and the solution of sulphate of copper renewed.

Galvanic cauterization is commonly practised with the electrode of Professor Middeldorpf, an instrument which contains two gilt copper wires that communicate at the handle

Fig. 188.   Fig. 189.   Fig. 190.

Marshall's Galvanic Seton.

Galvanic Cauteries.

with the poles of the battery, while its anterior extremity terminates in a platinum wire, wrapped spirally around grooved, hollow porcelain shells, which are rendered incandescent as soon as the circuit is established. The instrument and the variously shaped cauteries are exhibited, in miniature, in the preceding figure, while two are represented of the full size in figs. 188 and 189. They are designed for the establishment of issues, the destructive removal of superficial tumors, as the nævoid and epithelial, and the treatment of epithelioma, ulceration, and other affections of the mouth and neck of the uterus; and are placed in contact with the parts while cold, when the circuit is established, and continued until the desired effect is produced. The galvanic cautery of Mr. Marshall, of London, fig. 190, will be found to be a useful instrument for the management of rebellious sinuses and fistules.

The galvanic cautery, in the form of a loop of platinum wire, is a powerful, rapid, and generally bloodless agent for the removal of superficial tumors, polyps, portions of the tongue, the neck of the uterus, and malignant growths in situations in which the use of the knife would be difficult, and attended with severe and troublesome hemorrhage. It has been employed very successfully for the removal of growths of the larynx by Dr. Voltolini, and other practitioners; but Bruns, Mackenzie, and others are averse to its use, not only on account of the many inconveniences it causes to the patient and the trouble it gives to the surgeon, but also, and more especially, for the reasons that it is very difficult to limit the action of the incandescent loop to a small surface, and that, on that account, it is liable to produce acute œdema of the glottis.

The electrolytic treatment of tumors is more universally applicable, although it is far more tedious than the preceding method. The only instruments required are fine gold, or gilt steel, needles, and a sponge electrode. In performing the operation, the needle is passed into the interior of the growth, and attached to the negative pole of the battery, while the sponge electrode, previously wet with salt water, and connected with the positive pole, is placed outside on the skin. When the tumor is small, one needle will suffice; but when it has acquired considerable volume, the serres-fines conductor of Dr. Althaus will prove serviceable, as it permits the introduction of several needles in any direction that may appear most suitable. They should be insulated to within a short distance of their points with vulcanite, so that they may not affect the skin, thereby producing unnecessary suffering and subsequent inflammation.

Although the transmission of the current is not painful, yet, to prevent any unpleasant shock, the precaution should be taken of commencing with low power, and gradually increasing it to the full quantity that it is designed to employ. The duration of the application will vary according to the nature of the case, two or three minutes being sufficient for small tumors, while larger growths require from fifteen minutes to half an hour. The sittings may be repeated every second or third day. The number of cells, or the quantity of electricity employed, must be proportionate to the consistence of the tumor; solid

goitres and scirrhus, for example. demanding from thirty to forty cells, while other growths will yield to a battery of fifteen pairs of elements.

The best results from electrolysis have been obtained in vascular, sebaceous, and goitrous tumors, particularly the cystic variety ; in chronic glandular tumors ; in hydatid tumors of the liver ; in hydrocele, and in stricture of the urethra. In the treatment of aneurism it has almost been abandoned ; but it has proved successful in several cases of the cirsoid form of the disease that have been subjected to it. Nævoid, venous, and small sebaceous tumors rarely resist the influence of the galvanic current, while the testimony of Dr. Althaus and Dr. Mackenzie is strongly in favor of it in the management of goitre, the former observer believing " that all cases of bronchocele, however large, may be cured by electrolysis, if the treatment be persevered in for a sufficient time." Dr. Fagge and Dr. Durham, some years ago, recorded eight cases of hydatid tumors of the liver, in seven of which, one remaining doubtful, a cure was promptly effected. Dr. Ruschenberger, of our Navy, Scoutetten, and Pétrequin have cured obstinate hydroceles by introducing both electrodes into the sac; while other surgeons have successfully employed electrolysis in similar instances with the cathode only in the sac. The observations of Mallez and Tripier, Brenner, and others demonstrate that good results may occasionally be anticipated from it in the treatment of stricture of the urethra. Thus, of forty-four cases, only two proved fatal, and in only two febrile symptoms were set up. Electrolysis has also been employed in carcinomatous tumors, but a more extended experience is necessary to decide its applicability in these affections.

As a mode of counterirritation, needles are sometimes introduced into the tissues for the purpose of transmitting to the affected part a current of electricity or galvanism. The operation, denominated, in the one case, electro-puncturation, and, in the other, galvano-puncturation, is performed in the same manner and with the same instruments as in the ordinary process, except that the latter have a small ring at the top for receiving the conducting wires of the poles of the battery. Only two needles are used at first, but the number is gradually increased as the patient becomes able to endure the action of the current. When it is intended to produce a shock, a Leyden jar may be employed, but for maintaining a steady effect a small horizontal galvanic pile is the most appropriate apparatus. This mode of counterirritation is almost entirely restricted to the treatment of chronic affections attended with deep-seated and inveterate pains, as gout, rheumatism, neuralgia, and sciatica.

SECT. XII.—ANTISEPTICS.

The employment of antiseptic agents has for its object the prevention and arrest of putrefaction in wounds, whether accidental or surgical, by devitalizing or rendering inactive the germs which induce it. According to the panspermic theory of Pasteur, the atmosphere is loaded with invisible living germs, which, coming in contact with the putrescible material—effused blood and plastic matter—of open wounds, induce decomposition and consequent irritation, which, in its turn, gives rise to suppuration and constitutional disorder. Hence the aim of the antiseptic method of treatment is to destroy the septic energy of the atmospheric germs, through which putrefaction and the morbid processes which result from it are prevented.

Although the researches of Pasteur, Virchow, Rindfleisch, Hueter, Vogt, Sanderson, Klebs, Cohn, Cheyne, Lister, and other observers have established the existence of myriads of low forms of organisms in our breathing atmosphere, the demonstration of living, disease-producing germs is wanting. Hence, physicians, myself included, have been somewhat chary in accepting the germ theory of the decomposition of animal matter. There is not the slightest difficulty, on the other hand, in comprehending that the atmosphere of ill-ventilated and long-occupied hospitals contains a noxious, invisible, permeable dust, holding in suspension epithelial and pus cells and other particles of organic matter, which is capable, by direct contact with wounded surfaces or open sores, of inducing putrefaction, suppuration, and their evil consequences, and also of giving rise to the phenomenon of blood-poisoning through its absorption by the lungs. During our late war I had repeated opportunities of observing the toxic effects of the tainted atmosphere of our city military hospitals, and the rapid improvement in the condition of the wounded upon their removal to the purer atmosphere of tent hospitals in the vicinity of the city. My experience, moreover, in private practice, has convinced me that abscesses may be opened, that wounds, as those made in the removal of tumors, may close, and that compound fractures may unite, as readily without as under the use of antiseptic agents, and I have, therefore,

of late, employed them, not to prevent, but merely to arrest the processes of putrefaction, and to destroy its products. In hospital practice, however, prevention should be aimed at.

Among the antiseptic agents are generally, but improperly, included certain articles which should be classed as deodorants, as chlorine, bromine, iodine, and permanganate of potassium, all of which oxidize the gaseous products of decomposition, destroying their odor, but exerting no effect upon the specific virus or septic germs. Solutions of the metallic salts, as the chlorides of zinc and aluminium, the sulphates of zinc and copper, and nitrate of lead in the form of Ledoyen's disinfecting fluid, perchloride of iron, bichloride of mercury, through oxidation of the morbific agent, and their chemical action on the tissues, must be ranked among the septicides as well as deodorizers.

A solution of *chloride of zinc*, of the strength of forty grains to the ounce, was highly recommended by Mr. De Morgan, as a permanent antiseptic, its action penetrating the tissues deeply, and forming with their albuminoid constituents a dense coagulum incapable of putrefaction. The wound, exposed tissues, or cavity of an abscess, should be soaked with the solution by irrigation and sponging, and the application need not be repeated, as its effect is permanent. Perchloride of iron, in aqueous solution, is one of the best articles of this class, as it forms a resisting, adherent coagulum, which is readily absorbable as cicatrization advances.

Chloralum, or chloride of aluminium, is a very powerful septicide and deodorizer, non-poisonous, astringent, styptic, devoid of odor and causticity, and is particularly serviceable in wounds, hemorrhages, and foul discharges, absorbing noxious gases and destroying parasites and germs. The agent in general use which it most closely resembles is chloride of zinc.

Of the antiseptics, properly so called, by far the most efficacious are carbolic acid, sulphurous acid, the sulpho-carbolates of zinc and copper, eucalyptus, thymol, and iodoform.

Carbolic acid is a powerful disinfectant and antiseptic, effectually destroying the germs which induce putrefaction, and arresting the process when it has set in. It is not a deodorizer, but unhappily substitutes one bad odor for another, and in this respect it is inferior to the other septicides. On account of its destructive action on all minute forms of organisms, which cannot exist in its presence, it has been employed with alleged remarkable success, by Professor Lister and others, for preventing the access of putrefactive fermentation in compound fractures and dislocations, lacerated wounds, amputations, excisions, and different kinds of abscesses, especially chronic. It should be remarked, however, that the solutions usually employed are entirely too weak to act as germicides, and that if the strength be increased the agent proves to be not only a direct irritant, but is also liable to excite alarming effects of narcotico-irritant poisoning, which generally terminate fatally. For these reasons carbolic acid is now employed less frequently than it was a few years ago, the agents with which it is being replaced being thymol and eucalyptus.

Sulphurous acid is one of the most valuable and powerful of the septicides, and possesses the advantage over most of the other agents of this class of being, at the same time, a deodorizer. The fluid acid of full strength may be applied to wounds and ulcers either by sponging or in the form of spray. It is superior to carbolic acid when added to moist, putrefying matter, as it not only destroys organic germs, but also the odor of the mephitic gases of decomposition, a property not possessed by the latter agent.

Sulpho-carbolates of zinc and copper have been employed in the treatment of wounds by Professor John Wood and others, in the proportion of three to five grains to the ounce of water. The solution may be applied by irrigation, or by patent lint covered with some impermeable material, as gutta-percha cloth. As direct antiseptics they are inferior to carbolic acid, sulphurous acid, and the metallic salts; but, as Mr. Sansom observes, their value lies in the protraction of their action, the carbolic acid being slowly liberated by the disintegrating action of the fluids on the salts.

Eucalyptus and thymol, like all aromatics, are excellent remedies for substituting a pleasant for an offensive odor, and for restraining putrefactive fermentation. They do not, moreover, irritate the tissues, nor do they produce toxic effects upon the system. As an antiseptic dressing, eucalyptus may be employed in the form of the oil or alcoholic tincture, while the best solution of thymol consists of one part of that substance to ten of alcohol, twenty of glycerine, and one thousand parts of water.

Iodoform is at present attracting no little attention as an antiseptic, especially in the hands of German surgeons. It may be sprinkled upon the wound, or the latter may be

enveloped in gauze impregnated with it. The pungent odor of the remedy may be corrected by the use of the Tonka bean, or by the addition of two parts of balsam of Peru, or of one-tenth of its weight of thymol, which do not appear to impair the efficiency of its action. Great care should be exercised in its employment in infants and in extensive wounds, since it has occasionally proved fatal, under these circumstances.

<center>SECT. XIII.—ESCHAROTICS.</center>

There is a class of operations which consists in destroying the affected tissues with caustics, consisting of the hot iron and of various escharotic substances. These procedures, however, once so much in vogue among surgeons, have become almost obsolete, although they are perhaps still too much practised in certain quarters, especially in France. At the present day they are restricted, in great measure, to affections of the neck and orifice of the uterus, superficial morbid growths, hemorrhoidal tumors, varicose veins of the extremities, specific ulcers, as chancroids, and malignant pustules, and bites of snakes and rabid animals.

When the hot iron is used for any of the purposes in question, it should be heated to a white heat, and retained in contact with the diseased parts sufficiently long to effect their destruction, their surface being previously thoroughly dried. In performing the operation, the surrounding structures should be carefully protected from injury, and in order to obtain the desired result it is frequently necessary to have two, three, or even four cauteries in readiness, so that, as one becomes cold, another may take its place. The eschar generally drops off at a period varying from six to eight days. The best apparatus for heating the iron is a little furnace charged with charcoal, the combustion being promoted with a pair of bellows. The

Fig. 191.
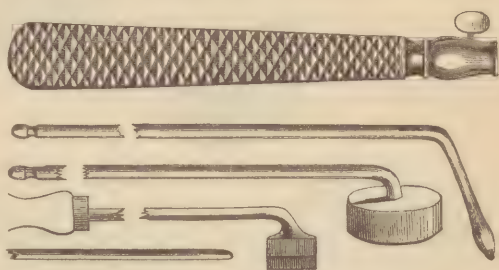
Different forms of Cauteries.

annexed sketch, fig. 191, conveys a good idea of the principal forms of iron in use at the present day. The conical-shaped instrument is well adapted for cauterizing narrow and deep-seated cavities, and the cylindrical one may also be used for this and similar purposes. The hatchet-shaped iron is well adapted for making a linear eschar, and the large round one for establishing a deep, permanent issue.

Many of the inconveniences attendant upon the use of the ordinary hot iron may be done away with by the employment of the *thermo-cautery* of Paquelin, represented in fig. 192. The platinum tip, *a*, which is the essential part of the contrivance, is first heated in the flame of an alcohol lamp, *b*, and then rendered incandescent by compressing the bulb, *c*, through which a steady stream of painter's benzine of 0.715 sp. gr. contained in the bottle, *d*, is carried to *a*. Unless great care be exercised the apparatus is liable to get out of order; hence it should be thoroughly cleaned every time it is used.

Hydrate of potassium, ethylate of sodium, the Vienna paste, chloride of zinc, bichloride of mercury, arsenic, ammonia, and certain acids, as the nitric, hydrochloric, and sulphuric, are powerful caustics, producing their peculiar effects more or less promptly, according to the length of time during which they are retained, and the strength in which they are used. As their application is generally attended with severe pain, it is proper that the patient be previously put under the full influence of an anæsthetic. Moreover, as some of the articles here specified have a tendency to diffuse themselves over the surrounding healthy surface, care should be taken to prevent this by placing a wall of simple cerate or collodion around the part to be cauterized.

Hydrate of potassium is a powerful escharotic, but as it is extremely painful and very tardy in its action, it is now seldom employed. The Vienna paste, composed, as already stated, of equal parts of quicklime and hydrate of potassium, although also productive of severe suffering, does its work much more rapidly—generally in from ten to fifteen minutes—and is, therefore, usually preferred. Hydrate of potassium is often used most conveniently in the form of small sticks.

The *ethylate of sodium* which is converted into caustic soda when brought in contact with moist tissues, is a gradual but potent agent, which I have found to be very useful in

cicatrizing epithelioma, rodent ulcer, and other malignant affections in which the use of the knife is contraindicated. If the pain produced by its application should be severe, it may be checked by dropping chloroform upon the part, which converts the agent into an inert ether and chloride salt.

Fig. 192.

Thermo-cautery of Paquelin.

Chloride of zinc is usually mixed with farina, forming thus what is called the phagedenic paste of Canquoin, of which there are three strengths, known as number one, two, and three; the first consisting of one drachm of the salt to double that quantity of farina, the proportions of the second being as one to three, and of the third as one to four, the latter being of course much the weaker. The preparations act with great efficiency, but are productive of excessive pain.

Bichloride of mercury, in the proportion of three parts to one of powdered opium, with the addition of a sufficient quantity of sulphuric acid to convert it into a paste of the consistence of tar, makes a powerful escharotic; but, owing to the excessive pain which it causes, and the risk of its inducing salivation, it is now rarely used. A similar objection is applicable to the caustic mixture, formed of equal parts of white arsenic and sulphur, formerly so much in vogue. A decided escharotic effect may speedily be produced by the use of equal parts of ammonia and lard.

A very destructive escharotic, admirably adapted for the removal of epithelial growths, may be prepared with fifteen grains of white *arsenic*, seventy-five of cinnabar, and thirty-five of burnt sponge, made into a thick paste with a few drops of water. This constitutes what is called Manec's paste, and is applied in the form of a thin layer to the surface of the affected part, previously well cleansed in order to promote its effects. The great objection to this remedy is the excessive pain it produces and its liability to cause vomiting, depending, doubtless, upon the absorption of some of the arsenic. Generally, also, its application is followed by deep discoloration and severe swelling. For these various reasons it should be employed with great caution, or be replaced by Esmarch's powder, which is composed of one part each of arsenious acid and muriate of morphia, eight parts of calomel, and forty-eight parts of powdered gum arabic.

The *carbo-sulphuric* paste, as it is termed, is prepared by mixing powdered charcoal and sulphuric acid in sufficient quantities to form a semisolid mass. It is a powerful escharotic, formerly much employed by Ricord in the treatment of chancroid. Applied in the form of a thin layer, it rapidly destroys the tissues, and soon dries into a thick, adherent crust, which usually drops off in from six to eight days, leaving a clean sore. The only objection to this caustic is that it causes excessive pain.

The stronger *acids*, as the nitric, hydrochloric, and sulphuric, produce an instantaneous escharotic effect when applied to a denuded surface; hence they are often used for cau-

terizing inoculated wounds and destroying the edges of ulcers. Of all the acid preparations, however, the best and most reliable is the *acid nitrate of mercury*. The formula which I employ is that usually known in this country as Bennet's. It is prepared by dissolving, with the aid of heat, 100 parts of mercury in 200 parts of nitric acid, and evaporating the solution to 225 parts. The application produces a white eschar, which is detached, piecemeal, from the third to the tenth day. *Chromic acid* also deserves favorable mention; its application, which causes but little pain, is particularly valuable in cases of warty excrescences and of recent chancroids. When merely a superficial caustic effect is desired, *carbolic acid* will be found highly serviceable: it is particularly beneficial in unhealthy, suppurating wounds, in gangrenous ulcers, and in open carcinomas attended with foul discharges, the odor of which it promptly and effectually arrests. It may be used pure, or variously diluted with glycerine, according to the intention of the application. Whatever article be employed, the utmost care must be taken to prevent its diffusion over the surrounding healthy tissues, otherwise the effects may be most unfortunate. Cauterization with *caustic arrows* is a method of destroying the tissues in carcinomatous and other growths originally employed, in 1858, by Maisonneuve, of Paris. It is particularly applicable to carcinoma of the breast and uterus, but is also practised, especially by its inventor, in epithelioma of the lip, tongue, tonsils, palate, anus, and rectum. The arrows are flattened, wedge-shaped pencils, of variable sizes, cut from a thin cake of dough, composed of three parts of wheat flour with one of chloride of zinc, as much water being added as may be necessary to give the mass proper consistence. When the arrows are dried, they may be kept a long time without losing any of their properties. To facilitate their insertion, a small preliminary incision in the skin is required. The number employed varies, of course, with the amount of substance to be destroyed. As the attendant pain is very great, the patient should always have the benefit of a full anæsthetic. The necrosed tissues gradually become hard, black, and insensible, and drop off at a period varying from six to twelve days, leaving a raw surface which, under the influence of mild emollient dressings, is soon covered with healthy granulations. The advantages claimed for this method of cauterization are that it is entirely free from hemorrhage, that it may be employed in situations inaccessible by the knife, and that it is rarely followed by erysipelas, pyemia, or violent fever. These advan-

Fig. 193.　　　　　　　　Fig. 194.

Fig. 193.—Maisonneuve's Plan of Circular Cauterization by Wedge-Shaped Pieces of Caustic.

Fig. 194.—Maisonneuve's Plan of Parallel Cauterization by Lancet-Shaped Pieces of Caustic.

tages, however, have been greatly overrated. Copious bleeding sometimes accompanies, or succeeds, the application; nor are the other ill effects as uncommon as the French surgeon asserts. The annexed cuts, figs. 193 and 194, afford a good idea of the shape of the arrows and the manner in which they are inserted.

Perchloride of iron is a very mild, but in many cases a very efficient caustic, and at the same time a powerful hemostatic, producing rapid contraction of the vessels, and checking hemorrhage at once with very little pain. It is particularly adapted to carcinomatous sores and old ulcers attended with exuberant and flabby granulations. It may be applied either in substance or in saturated solution. A few drops may occasionally be advantageously injected into the tissues at the periphery of a fungating and bleeding tumor.

SECT. XIV.—MASSAGE.

Massage, in its original sense, implies kneading; but, as at present used, it has a much wider signification, comprising all kinds of passive manipulation, as friction, shampooing, percussion, and rolling of the soft parts. As a therapeutic agent, it has been in vogue, in some form or other, from time immemorial, although it has only been, of late years, chiefly through the influence of the labors and writings of some of the Danish physicians, that it has attracted much attention. Its principal claim to notice is in connection with the

treatment of subacute and chronic affections of the joints, in which in the hands of the skilful operator, it is frequently productive of very marked benefit. It may also be advantageously used in subacute and chronic cellulitis, attended with deposits of serum and lymph, especially the latter, and consequent induration of the soft parts. Massage has also been found serviceable under similar circumstances in affections of the lymphatic glands.

The beneficial effects of massage are, doubtless, due to the influence which it exerts upon the lymphatic vessels, and possibly, also, upon the veins, stimulating them to augmented action, and thus inducing them to remove inflammatory deposits. These vessels during the progress of disease are often so thoroughly choked up by plasma and other material as to deprive them completely of their power as absorbing agents. They are, indeed, not only compressed by, but frequently even filled with, these substances. The object in the employment of massage is to increase the activity of the lymphatic vessels, so that, by the ridding of them of these deposits, they may be enabled to resume their normal condition, and at the same time assist in restoring the structures around them to their natural size, shape, and pliancy. What the husbandman does for his grain when choked by weeds, massage does through the agency of the absorbent vessels for the affected structures.

Massage, in whatever form employed, may be used dry, or with the aid of various lotions, embrocations, liniments, or unguents, according to the fancy or caprice of the operator, or the special indications of the case. Dry massage is particularly applicable in chronic affections, whereas the other form is generally best adapted to the subacute. There are of course many exceptions ; and, to render the remedy effectual in every case, it must be frequently varied.

The treatment by massage is wholly inapplicable during the height of inflammatory action, or during the existence of suppuration. The parts covered with hair should be well shaved before the operation is begun, otherwise irritation will be likely to be set up in the piliferous bulbs, so as to interfere more or less seriously with the result. The period during which the manipulations should be continued must vary, according to circumstances, from a few minutes to half an hour or more.

In regard to friction, there are two principal directions in which it may be employed, the transverse and vertical, the former being more especially adapted to the removal of deep-seated, and the latter to superficial, affections and deposits. To render the rubbing, in whatever direction made, effective, both hands previously oiled are generally required. Kneading, rolling, and percussing the structures are often important auxiliary measures, powerfully aiding in the removal of plastic material. In the treatment of stiff joints, passive motion should always be performed immediately after the massage, and the parts, if need be, should be covered in the intervals of the operation with compresses wet with cold water, or some astringent and sorbefacient lotion. The absorption of effused fluids is often powerfully promoted by combining massage with irritating embrocations, liniments, or unguents.

Muscle-beating is a peculiar form of massage introduced by Klemm, of Riga. It is performed with an instrument called the muscle-beater, consisting of three elastic tubes, each about the size of a finger, and fastened together near the handle to which they are attached. The length of the tubes varies according to the object it is desired to secure. The skin should be protected with a thin cloth covering, and the force used in the beating proportioned to the impressibility of the patient. The application which should be interrupted by short pauses, should not be too long continued, lest undue irritation be excited. Muscle-beating may be advantageously practised in various chronic affections, attended with stiffness or partial ankylosis, sprains, rheumatism, dislocations, fractures, spinal weakness, and locomotor ataxia. With a little instruction in the use of the instrument, the patient can perform the manipulations as well as the professional attendant. An elastic hammer having a surface one inch and a half in diameter would answer quite as well as Klemm's elastic tubes ; and, in their absence, effective muscle-beating could readily be performed with the thick part of the palm of the hand.

SECT. XV.—DRESSING.

The art of dressing, humble though it be, must not be despised by the surgeon ; since, in many situations, both in private and hospital practice, it must necessarily form a part of his daily routine duties. There is, indeed, great reason to believe that this matter is

too much neglected by practitioners, and that it is too frequently delegated to ignorant, careless, and unscrupulous nurses, and to the so-called dressers, who are often not a whit more enlightened, or more con-
scientious.

Fig. 195.

The most important appliances used in dressing are forceps, scissors, and syringes, sponges, lint, pledgets, tents, adhesive plaster, bandages, cataplasms, and unguents.

Dressing Forceps.

The *dressing forceps*, fig. 195, differs from the ordinary dissecting forceps in having ring handles, and cross blades, terminating each in a rounded, spoon-shaped extremity, supplied internally with serrated edges, to adapt it the better for seizing and holding such substances as may require removal. They are light and slender, and from four and a half to five inches in length. When not at hand, the ordinary dissecting forceps may advantageously be used as a substitute.

The best *scissors*, for dissecting purposes, are the ordinary straight, pocket-case instrument, which may be used either for cutting adhesive strips and bandages, or, if necessary, for paring the edges of ulcers, or for removing redundant granulations. Scissors curved on the edge or flat are sometimes very convenient.

The *sponges* used in dressing should be very soft and clean, and the same articles should never be employed upon different persons, especially if affected with open ulcers, as the discharges might thus be made the vehicle of propagating disease, as, for instance, in chancroid, gonorrhœa, erysipelas, malignant pustule, pyemia, and hospital gangrene. In all such cases they should be destroyed as soon as the dressing is completed, or thoroughly washed in water, and then soaked in a solution of chlorinated sodium or carbolic acid.

No sore should ever be wiped; instead of this, the water should be pressed upon it from a sponge held some distance from its surface, which will usually effectually wash away any secretions that may be in contact with it. Adherent lymph, charpie, or unguent may be picked away with the forceps. The surface around, however, may be gently sponged, if soiled; otherwise it may be wiped with a soft, dry cloth. The water, which may be tepid, cool, or cold, according to circumstances, is received into a suitable basin, placed beneath the affected parts. The old dressings are put into a separate vessel, and promptly removed from the patient's apartment. Fetor is allayed by the free use of deodorizers, sprinkled both upon the body and bedclothes, as well as about the room.

Lint is a soft, fleecy substance, consisting either of prepared cotton or scraped linen, or, what is preferable, the ravellings of linen, as those of an old napkin, sheet, or pillow-case, each thread being picked out separately. The article generally employed in this country is patent lint, which is kept in rolls in the shops, and makes an excellent dressing, although not equal to linen ravellings, or the charpie of the French surgeons: one surface is glazed, the other smooth. The objection to it is that it is not sufficiently porous to admit of the free escape of the secretions of the parts to which it is applied, and, consequently, also, that it keeps them too warm.

A very excellent, cheap, and convenient article for dressing wounds and ulcers may be prepared by folding a piece of old muslin, until it forms a body from a quarter of an inch to half an inch in thickness, and then punching numerous holes into it, giving it thus a sieve-like appearance. It is very light and airy, and, while it absorbs moisture, it also admits of ready drainage. It forms a good substitute for patent lint, and is much used, both in private and hospital practice, in cases where the other is not applicable. It is known as perforated muslin.

Oakum, consisting of picked ship rope, was extensively used during the late war as a dressing in gunshot and other wounds, attention having been specially directed to it in connection with this subject by Professor Lewis A. Sayre. It combines cheapness with softness, is easily adapted to the affected surface, and, being impregnated with tar, is an excellent antiseptic and deodorizer. As an absorbent, however, it is far inferior to patent lint, charpie, and tow.

Instead of oakum, *tenax* is now much employed as a dressing for wounds. It is an absorbent and antiseptic substance, which possesses the tarry odor of oakum, but is much softer and lighter, and readily imbibes and retains the secretions of the affected surface, at the same time that it effectually prevents any unpleasant emanations. Its cheapness is an additional reason for its employment.

Tow has long been employed as an absorbent of persistent discharges in wounds and ulcers, and, if properly picked and carded, is equal to any substance that can be applied for the purpose. The ordinary article contains so much hard, sharp matter as to be unfit for use.

Cotton-wool, saturated with water, tepid, warm, or cold, may often be advantageously employed for cleansing wounds, as it is less irritating, when applied directly to the raw surface, than sponge. It may also be conveniently used as a medium of medicated dressings.

Spongiopiline is a valuable dressing. It is a soft, light, porous fabric, made of sponge and muslin, in sheets from half an inch to an inch in thickness, covered with a glazing of India-rubber, to fit it the better for retaining water and preventing evaporation. It is more particularly adapted as a dressing to inflamed surfaces unattended with breach continuity.

Paper, prepared in various ways, forms a very good cheap substitute for patent lint as a surgical dressing. Professor Agnew, some years ago, recommended the use of a very thick, soft paper, made of old rags, deodorized with chloride of lime. One surface is velvety, and the other dense and leathery.

Sometimes the lint is arranged in the form of a *compress*, pledget, ball, roll, tampon, tent, or pellet, thus adapting it the more conveniently to particular purposes. Thus, a compress consisting of a strip of folded muslin, lint, or linen, may be employed for pressing together the sides of a deep abscess, or a number of pieces may be piled upon each other, so as to form a graduated compress, which is often advantageously used for compressing a bleeding vessel, as the brachial artery where it runs along the inner edge of the flexor muscle. The *pledget* is a strip of patent lint, usually spread with cerate, for protecting the surface of a granulating ulcer. Balls, rolls, and tampons are simply masses of soft substance, as charpie, lint, or cotton, arranged so as to adapt them to particular cavities, as the uterus, the nose, or a deep wound, either with a view of arresting hemorrhage, or for absorbing pus and other fluids. The *tent* consists of a piece of linen, muslin, or patent lint, twisted on its axis, slender, and usually several inches in length, its object being the prevention of the reunion of the sides of the incisions made in evacuating abscesses, and in laying open sinuses, as in the operation for anal fistule. Tents are sometimes prepared with wax, generally of a conical shape, and employed as dilators. Finally, the *pellet* is a ball, roll, or mass of soft tissue, inclosed in a strip of soft cloth, firmly tied; it may be used for the same purposes as the tampon, of which, in fact, it is

Fig. 196.

Drainage-tube and Forked Probe.

merely a variety. When intended for the nose, uterus, or rectum, a stout thread or piece of twine may be tied to it in order to facilitate its removal. Dr. Addinell Hewson employs ordinary paper, similar to that used for printing purposes. When the object is to confine heat and moisture, as in the application of a poultice or warm water-dressing, the best article is oiled silk, or when this cannot be obtained, oiled paper or impervious lint.

The *drainage-tube*, as a means of favoring the discharge of matter from abscesses and sinuses, especially when large, devious, or deep seated, is not, as has been generally supposed, a recent invention, but of ancient date, extending back to the time of Ambrose Paré, by whom it is repeatedly mentioned in his great work on surgery in connection with gunshot wounds and injuries of the chest. He speaks of it as preferable, in many cases, to tents, in freeing wounds and ulcers of irritating matter, and promoting the formation of healthy granulations. He used lead and various other materials in its composition, with apertures near its extremities. The surgeons of Philip II., king of Spain, employed drainage-tubes in the treatment of that monarch's case to drain a large abscess with which he was afflicted. To Chassaignac, however, is unquestionably due the credit of calling the attention of the profession to the subject in modern times, and of pointing out, in clear and distinct terms, the class of cases in which the drainage-tube can be used to the best advantage.

Drainage-tubes are composed of various materials, as soft rubber, fig. 196, decalcified bone, lead, or silver; they are cylindrical in shape, of variable length and diameter, and

perforated with numerous apertures, to admit of the free ingress of matter in every direction, at the sides as well as at the extremities. Whatever the substance may be, it should be smooth, light, and non-irritant, and the openings must be sufficiently large to prevent them from becoming clogged. No sulphur should enter its constitution, as this would impart an offensive odor to the secretions.

The late Dr. H. Lenox Hodge invented what he called a drainage-probe, which he considered preferable to the ordinary drainage-tube. It is made of flexible silver, and terminates at each end in an olive-shaped bulb.

Poultices form an important element in a great variety of dressings, but as this subject has already been fully described, I shall here only add, that when they are selected for this purpose, they should be used with special reference to the comfort of the parts, care being taken that they do not oppress by their weight, or irritate by their long retention and the stimulating character of their ingredients. The mode of employing water-dressings has also been so fully considered in another part of the work as to render any further remarks regarding them here unnecessary.

Unguents, ointments, or salves of various kinds are employed as dressings in ulcers and other open surfaces; much has been said and written upon the subject, especially of late years, and attempts have been made to discard these substances altogether from practice. Still, notwithstanding all this, unguents hold a prominent place in the affection of many practitioners, as well as in that of the common people, and it would be difficult, I am sure, always to dispense with their use. Prejudice, I imagine, has had much to do in proscribing this class of remedies. No one will pretend to assert that rancid ointments do not act as irritants; this, however, is not the fault of the article, but simply of its misuse. Prepared and employed for the occasion, experience shows that the application of unguents is often attended with the most salutary effects, admirably protecting granulating surfaces, and rapidly promoting cicatrization. As a general rule, I have found that all the officinal medicated ointments are much too strong, requiring to be diluted from one-half to seven-eighths. Petroleum has, in great degree, taken the place of most of the older simple ointments, inasmuch as it is less liable to become rancid and offensive. Cosmoline or vaseline is one of the most approved preparations of this kind, and another, recently introduced, is fossiline, a hydrocarbon jelly of superior consistence and smoothness.

Glycerine, either alone or variously combined, forms an excellent dressing in granulating wounds and ulcers, in different eruptive diseases of the skin, in ulceration of the uterus, and in certain forms of deafness, especially when dependent upon dryness of the drum of the ear, or the presence of indurated wax. Although its utility has been greatly exaggerated in these and other affections, it is unquestionably a valuable addition to the domain of modern surgery. It is best applied upon soft cotton or coarse lint, previously well pressed out of tepid water. Its effect, thus employed, is to exclude the air, to keep the sore moist and clean, and to favor capillary drainage by osmosis, thereby depleting the tissues, provoking a copious discharge of serum, lessening suppuration, and promoting cicatrization. Glycerine has great affinity for water, and a bit of cotton saturated with it will retain its humidity for days, even if continually exposed to the air. It has the additional advantage of being perfectly bland, non-adherent, and easily removable by ablution.

Glycerine may often be advantageously combined with other articles, as tannic acid, opium, soda, and the mineral acids, according to the indications of the case.

Dr. Hewson has extensively employed *dry earth* as a dressing in burns and scalds, ulcers, wounds, both recent and suppurating, and in compound dislocations and fractures, with the effect, not only of excluding the air and preventing the offensive odor so common in such cases, but also of allaying pain and hastening the healing process. Dr. Darby, of Boston, has been equally successful in the management of these affections with the use of carbolized dry earth and carbolized bran.

The earth, as used by Dr. Hewson in his dressing, is always taken at a depth of from two to three feet below the surface, and is kept in large dry lumps until needed, when it is pulverized, sifted, and applied, either dry, as in an open surface, or converted into a thick paste with water when employed as a sorbefacient, as in the case of sprains, contusions, or tumors, a layer half an inch thick, confined in muslin, and covered with a suitable bandge, generally sufficing. Or, instead of this, the paste may be spread all over the affected parts, or applied on strips. The dressing is renewed as soon as it becomes offensive or ceases to produce the desired effect. In most cases it is necessary to effect the change on a sound surface by the end of the third day, and, on an open one, as often as every twenty-four hours.

Compressed sponge as a remedial agent, in the form of conical tents, as represented in fig. 197, or of flattened plates, is particularly useful in the treatment of sinuses and fistules,

Fig. 197.

Sponge-Tent
Holder.

strictures of the rectum, contraction of the canal of the neck of the uterus, chronic enlargement of the lymphatic glands, venereal buboes, and chronic swelling and induration of the testicle and mammary gland. It may also be advantageously employed for dilating the female urethra, and the wound made in the operation for the relief of atresia of the vagina and anus. The late Dr. J. P. Bachelder, who published an elaborate article on this mode of treatment in the New York Journal of Medicine for May, 1859, asserts that he had repeatedly employed it with great benefit in the suppression and arrest of various morbid growths, both benign and malignant, and similar testimony is borne by other observers.

The sponge, which should be soft, elastic, and well cleaned but not bleached, may be compressed with any heavy weight, or, what is better, a special apparatus, and, when perfectly dry, cut into strips of appropriate size and shape. When the object is to compress a swollen and indurated organ, as the breast or testicle, the piece should be sufficiently large to embrace the whole of the affected structures, to which it should be secured with a suitable bandage, the dressing being kept constantly wet with cold water, to promote the expansion of the sponge. Change or substitution is affected whenever pain, discharge, or fetor renders it necessary.

When sponge is intended to be used for sinuses or mucous outlets, it should be formed into tents by cutting it into conical pieces, slightly tapering at the end, from one to two inches and a half in length, traversed by a wire in the long axis, saturated with thick mucilage of gum arabic, and tightly wrapped around with small twine, beginning at the narrow extremity, and gradually terminating at the larger. When perfectly dry, the wire and cord are removed, and the surface smoothed with fine sand-paper. Daily substitution is effected, as the sponge soon becomes filthy, fetid, and worthless, not only exciting irritation and discharge, but endangering the system by pyemia. These effects may, it is true, be in some degree, counteracted by the addition of a little carbolized glycerine, but the objection to this is that it sometimes interferes with the expansion of the sponge.

The period during which the application should be continued must vary with the nature of the case. Great dilatation of a sinus or natural canal, as the urethra or vagina, may usually be effected in a very short time, and an enlarged breast or testicle may often be astonishingly reduced in a few days.

The stem of the *sea tangle*—the *laminaria digitata* of botanists—is another article that may be advantageously used for dilating purposes. The only objection to it is the presence in it of a certain amount of iodine, sodium, and potassium, which causes it to be more or less irritating to the parts with which it is brought in contact. Previous

Fig. 198.
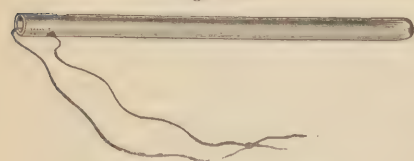
Greenhalgh's Sea-tangle Tent.

thorough maceration in simple water, however, will readily deprive it of this quality. Its extraordinary expansion under the influence of the warmth and moisture of the living tissues admirably fits it as an agent for rapid dilatation. Its surface, which is naturally rough, should be well smoothed before it is introduced. Dr. Greenhalgh uses a tubular sea-tangle tent, fig. 198, as it expands more rapidly than the solid one. Tupelo tents, to which attention has been called by Dr. Leopold Landall, are prepared of the root and stem of the nyssa aquatica, and form excellent dilators in contracted conditions of the vagina, uterus, and other mucous canals. Their superiority over sea tangle and sponge-tents consists in their more rapid and uniform expansion.

Whatever the dressings may be, they should be carefully confined by means of a bandage, evenly and lightly applied, so as to afford the requisite support, and no more. In most situations, this may readily be done with the common roller; but in certain regions, as the groin, perineum, anus, and head, particular contrivances may be necessary, as the spica, the T bandage, and the four-tailed bandage. For retaining dressings upon the scrotum and mammary gland the suspensory bandage will be found most convenient. Adhesive strips also answer a good purpose.

For confining the heat and moisture of poultices and warm water-dressings *oiled silk* is usually employed, although oiled or waxed paper answers quite as well, and, as it is much cheaper than oiled silk, it is entitled to preference for general use. To maintain cleanliness, frequent substitution should be effected.

A very cheap and convenient dressing made of thick porous paper, rendered water-tight on one surface with a film of India-rubber, was introduced at the Pennsylvania Hospital, a few years ago by Professor Agnew, and has been found very serviceable as an application in wounds and other affections, as it not only readily absorbs their secretions, but prevents the evaporation of water and other fluids.

The adjoining cut, fig. 199, represents the "ward carriage," as it is called, devised by Dr. Thomas G. Morton, of this city, and used with such signal benefit since 1866 at the Pennsylvania Hospital. Its arrangements could not possibly be more perfect, more compact, or better adapted to the objects for which it was constructed. The carriage is made of oak, with gutta-percha tires, and is so light as to be easily pushed noiselessly across the floor from bed to bed. It is provided with a heating apparatus, a long gutta-percha tube for cleans-

Fig. 199.

Morton's Ward Carriage.

ing wounds and ulcers, and with compartments for the accommodation of jars, bottles, sponges, and, in short, all the means and appliances necessary for dressing purposes in a large hospital.
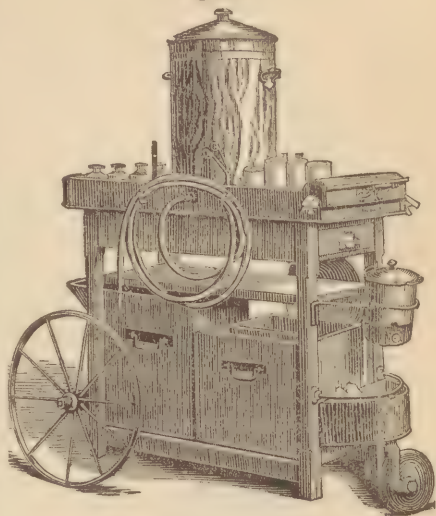
SECT. XVI.—BANDAGING.

Bandages are substances employed for retaining dressings in cases of wounds, ulcers, abscesses, fractures, dislocations, and other affections, as well as with a view to their direct curative effects, which, as will be shown by and by, are probably much greater than they are generally supposed to be. They vary much in shape and size, and also in regard to the materials of which they are composed, and the object which they are designed to fulfil. A vast number of bandages have been described in certain modern works, especially those on minor surgery, much ingenuity, and, according to my belief, much time having been wasted, in trying to adapt them to every part and region of the body, and to every circumstance, however insignificant, to which such contrivances can possibly be applied. By running into these extremes, the art of bandaging has been greatly complicated, and much injury inflicted upon a department of surgery, which, if properly administered, is capable of conferring immense benefit in almost every form of accident and disease affecting the external parts of the body. The ancient surgeons racked their brains to invent names for designating bandages, and the claims of not a few of them to distinction were based almost exclusively upon such absurd and puerile pursuits. If a man was so fortunate as to devise an apparatus for expelling peccant humors, for retaining a cataplasm upon the scalp, or for supporting a diseased breast, the height of his ambition was generally amply gratified. It is to be feared that these employments have had too many imitators in modern times.

The more simple a bandage is, the more likely will it be, if judiciously used, to answer the purpose for which it is intended, all complicated contrivances of this kind being objectionable on account of the difficulty of applying them, the ease with which they become deranged, and the trouble and vexation of changing them, the attempts to do so being frequently attended with serious inconvenience and pain to the patient, and perhaps great detriment to the parts affected. In general, the single-headed roller is all that can be required in almost any case; occasionally the strip-bandage, commonly known as the bandage of Scultetus, represented in fig. 200, may advantageously be employed, especially in compound fractures and dislocations. The many-tailed bandage ought, on the contrary, to be discarded from practice, as inconvenient and useless. It consists, as the name indicates, of a number of transverse slips, of the same width but unequal length,

stitched to a longitudinal portion, and was formerly much employed in fractures of the leg.

Bandages are composed of various materials; commonly of muslin, bleached or unbleached, of calico, or of linen, the only objection to the latter being its expense. Occasionally they are made of flannel, especially when it is desirable to protect the parts from cold, as in œdema of the extremities, and in the swelling attendant upon a gouty or rheumatic state of a joint, in persons of an unhealthy, broken constitution, who are commonly so extremely susceptible of atmospheric vicissitudes. In general, muslin will be found to answer every purpose, being both cheap and easily procured; it should be soft, firm, smooth, strong, and not too yielding, divested of selvage and seam, and washed before it is applied. Calico is not a good material for bandages, as it is usually too light and flimsy. The gum-elastic bandage is of great service in the treatment of old ulcers, in eczema of the lower extremities, in chronic affections of the joints, in elephantiasis, in chronic œdema, and in varicose conditions of the veins, and deserves more attention than it has hitherto received. Dr. Henry A. Martin, of Boston, is entitled to much praise for the pains he has taken to introduce this invaluable agent to the notice of the profession. The use of Esmarch's bandage in preventing hemorrhage in amputations and in the cure of aneurism is too well known to need comment.
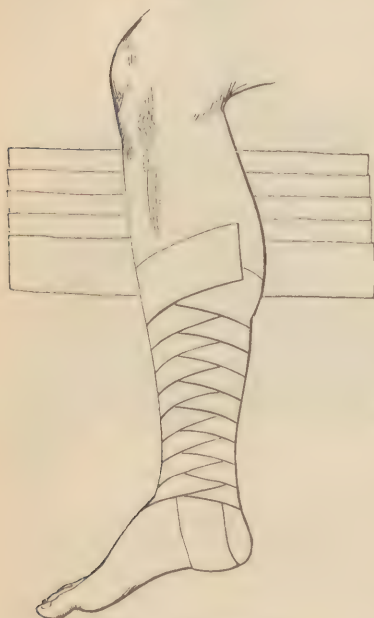
Fig. 200.

Bandage of Scultetus.

The length and width of a bandage are of course subject to much diversity, depending upon the shape and size of the part to which it is intended to be applied. Hence, while in one case it need hardly be half an inch in width, and not more than a foot in length, in another it may require a width of two, three, or even six inches, as in injuries of the chest, and a length of many yards. Muslin is usually torn into strips of the requisite size, whereas linen, being much stronger, is best shaped with the scissors. The ravellings being picked away, each piece is rolled into a firm cylinder, and put away for use, so that it may be ready for any emergency that may arise. The winding may be effected either by hand, the cloth being held upon the front of the thigh, or by appropriate machinery, such as is to be found in the office of every practitioner, and of which illustrations may be seen in most of the works on minor surgery. However effected, it should be done with great care, since no one can possibly apply a bandage well that has been wound in a loose and slovenly manner.

When intended to be used upon an extremity, the rule is always to begin at the distal portion of the limb, and to proceed from thence upwards some distance beyond the seat of the disease or injury. The end of the bandage being slightly unfolded, is held firmly upon the part with one hand, while the cylinder is carried round the limb with the other, and thus the application is continued by circular and reversed turns, as they are named, until the object has been completed, the fingers being pressed upon each reverse to flatten and equalize it, as in fig. 201. If the bandage were put on spirally, it could not maintain itself upon the limb for any length of time; and, what is worse, the compression would be so unequal as to cause severe suffering and perhaps even mortification. The application, then, must be made circularly, and care taken that each turn of the roller be reversed, so that the inner surface shall be the outer, and the upper edge the lower, the pressure being uniform throughout, or not greater at one point than at another, as in fig. 202.

The evil effects of unequal compression by the bandage are well illustrated in fig. 203, copied from John Bell; it also shows how important it is always to begin the application of the bandage at the distal extremity of a limb, and not above the wrist or ankle, as happened in the case so graphically described by the celebrated Scotch surgeon. In all cases of severe injury or disease, with a tendency to swelling and to the extension of the

morbid action, due allowance must be made for the inflammatory effusions that will necessarily occur. Hence, too much care cannot be taken both in applying the bandage and in watching its effects afterwards. For want of this precaution many a limb has been destroyed, and the reputation of many a practitioner irretrievably ruined.

Fig. 201.　　　　　　　　　　　　　　　　　　　Fig. 202.

Mode of Applying the Roller by Circular and
Reversed Turns.
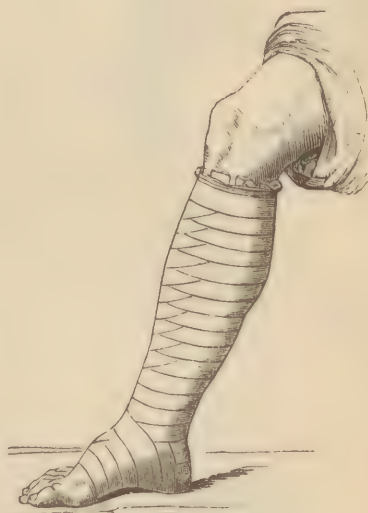
Appearance of the Bandage after it has been
Applied.

Some surgeons employ the double-headed roller; but I have never had occasion to use it, and am satisfied that there are few cases, if any, in which it may not be advantageously replaced by the single-headed. The double-headed bandage is considered as being particularly serviceable in the treatment of wounds penetrating deep among the muscles, where it is of paramount importance to effect accurate apposition of the deep as well as of the superficial sides of the solution of continuity; but even here no indication is presented that cannot be readily fulfilled with the compress and single-headed roller. In my own practice I have certainly never been at a loss in this respect.

The bandage of Scultetus, represented in fig. 200, consists of a number of strips, generally from ten to twenty, or of pieces of an ordinary roller, of equal or unequal length and breadth, according to the intentions of the surgeon. They are arranged in such a manner as that, when applied, each succeeding one shall overlap from one-third to one-half of the preceding one, the compression being made in the same gentle, uniform manner as in the employment of the ordinary roller. This form of bandage is peculiarly useful in the treatment of compound fractures and dislocations, in connection with which it will frequently be mentioned.

Bandages are sometimes applied wet; but in doing this much vigilance must be exercised, lest, shrinking too much as they dry, they produce a greater degree of compression than is compatible with the comfort and safety of the parts. What is called the starched bandage, an excellent modern device, will receive particular attention in connection with the treatment of fractures of the extremities, to which it is more especially adapted. When it becomes dry, it forms a stiff, firm, immovable case, well adapted to maintain the ends of a broken bone in contact with each other. Amidon, gum-shellac, plaster of Paris, and kindred articles may be used for the same purpose, the bandage being wet with them, and immediately applied to the affected limb.

The bandage, viewed as a therapeutic agent, has been too much neglected by modern practitioners. No one who has properly used it, or who is capable of properly applying it, can, for a moment, doubt its great utility; my experience with it for the last fifty-five years amply attests this fact; still, it is necessary that we should temper our enthusiasm, and that we should not allow ourselves to be betrayed into a species of hobbyism, calculated to mislead the judgment, and to bring surgery into discredit. Employed indiscriminately, it cannot fail, in many cases, to cause serious mischief, and to be followed by chagrin and disappointment. When the hand of a master is not present to direct and guide our practice, the result may frequently be most disastrous both to the patient and the surgeon. The evil effects of bandages, in their aggregate capacity, are hardly less serious than those of mercury, the lancet, and other potent remedies; or, if they are, it is only because they are less frequently employed. Numerous instances have come to my knowledge, where limbs, and even life, were the forfeit of their injudicious use.

Fig. 203.

Gangrene from Strangulation of an Injured Limb by Injudicious Bandaging.

It is not difficult to perceive how the bandage acts in producing its salutary effects. In fractures and dislocations, as well as in large wounds, it powerfully controls muscular contraction, and at the same time prevents tumefaction, by giving tone and support to the capillary and other vessels. Its influence as a sorbefacient is evinced in the rapid abatement of the swelling which so often follows compression by the bandage in erysipelas, œdema, and various kinds of injuries; or, more strikingly still, in orchitis, when, after the subsidence of the more active disease, the testicle is strapped with adhesive plaster, which is but another form of bandage. Here in a short time, ordinarily in less than twenty-four hours, the swelling usually so far disappears as to allow the organ to slip out of its artificial case; or, at all events, to such an extent as to require renewal of the dressing. The general effect of the bandage would thus seem to be somewhat similar to that of mercury, controlling capillary action, and promoting the absorption of effused fluids; but it has the additional advantage, and no trifling one it is, that it supports the muscles and prevents spasm, as is so remarkably evinced in fractures and in the stump after amputation.

Of the extent to which bandaging may be carried, a good idea may be formed from the frequent allusion that will be made to it in different parts of this work; it will suffice here to observe that it is applicable, as a general rule, to the treatment of all classes of wounds, from the most simple to the most severe, to fractures and dislocations, ulcers, abscesses, erysipelas, whitlow, orchitis, chronic inflammation of the superficial veins, and to nearly all affections of the limbs in which there is an effusion of serum, or serum and plasma.

A bandage, once applied to an open wound, especially if there be much discharge, should never be used a second time. However carefully washed, it is very difficult, if not impossible, to remove all the matter, and hence it may readily become a source of infection, causing erysipelas, pyemia, hospital gangrene, and other bad effects. The danger will be particularly great in a recent wound, in a person laboring under severe shock or loss of blood. Even the act of washing a dirty, filthy bandage is not always devoid of danger.

CHAPTER XV.

OPERATIVE SURGERY.

OPERATIVE SURGERY has too often been regarded as an opprobrium of the healing art. This opinion, as foolish as it is unfounded, is not peculiar to the public, who, in matters of this kind, are generally but poor judges, but has frequently been advanced even by medical men. That this department of surgery is often abused cannot be doubted ; but does it thence follow that it is a disgrace to the profession and an injury to the community ? Such a view would be absurd, because it would be utterly irreconcilable with the dictates of common sense and the results of daily experience. So long as the human body is liable to accidents, and so long as nature is incapable of arresting, by her own efforts, the various morbid processes which she herself institutes, so long will practitioners be compelled to invoke the aid, and, I may add, the blessings, of operative surgery. Is it a disgrace to amputate a leg for a mortification of the foot, to extirpate a testicle that has been destroyed by cystic disease, to divide the stricture in strangulation of the bowel, to remove a stone from the bladder, to extract a cataract, or to trephine the skull in a punctured fracture ? Surely, no one will doubt that in these, and a hundred other instances, our object can only be attained by an operation. Medicine, under such circumstances, however judiciously administered, is not only utterly futile, but is always ready to avail itself of the aid of surgery. Its empire is temporarily suspended, and it only resumes its legitimate functions after the use of the knife. It is true beyond doubt, and it is fortunate that it is so, that, in the hands of judicious and enlightened practitioners, a resort to instruments is much less frequent now than it was even ten years ago ; many limbs which would formerly have been subjected to amputation are now easily saved, and many diseases which were once regarded as utterly hopeless now readily yield under the influence of our therapeutic efforts.

Operative surgery, as practised at the present day, is entitled to the highest respect and admiration of the profession, and the most profound gratitude of mankind. It has attained, if not its finality, certainly a wonderful degree of perfection ; it has emerged out of chaos into order, and out of darkness into light ; it has laid aside its farrago of instruments, and its fondness for blood and torture ; in a word, it has assumed the fair and stately proportions of an exact science ; and little remains to be done, in order to place it upon a firm and immutable basis, beyond its efforts to determine the best plans by which it seeks to accomplish its various purposes. Within the last twenty-five years it has literally invaded every organ and region of the body, and achieved feats of a character evincive of the highest daring, of the most varied knowledge, and of the most marvellous dexterity. Once regarded as a disgrace, it can be regarded so now only when it is practised for base and selfish ends ; not when it interposes its humane and beneficent resources for the purpose of removing disease, prolonging life, and averting death.

Qualifications of a Surgeon.—The performance of operations presupposes the possessions of certain qualities on the part of the surgeon. It is not every man that can become an operator, even presuming that he has the requisite knowledge of anatomy and of the use of instruments. Courage, which is so indispensable, is possessed by comparatively few ; the sight of blood, and the idea of inflicting pain, were so disagreeable to Haller, that, although he taught surgery with great success for seventeen years, he never, it seems, during all that time, performed a solitary operation upon the living subject. Courage, like poetry, has often been said to be a gift of nature, and nothing is, perhaps, more true ; but it is equally certain that a timid man may, by attention to his education, and by constant practice, become, in the end, a good operator. Habit does a vast deal for us in such cases, for it literally becomes a second nature. I know a surgeon who in his youth nearly fainted at the sight of blood as it flowed from a vein of the arm into the basin, which it devolved upon him to hold during the operation of venesection, and yet who, by a course of self-training and a complete knowledge of anatomy, has made himself a thorough master of the knife. Celsus, long ago, happily defined the qualities which constitute a good operator. He should pos-

ses, says the illustrious Roman, a firm and steady hand, a keen eye, and the most unflinching courage, which can disregard alike the sight of blood and the cries of the patient.

But the above are not the only qualities, important though they be, which an operator should possess. If he is not honest in his purposes, or scrupulously determined, in every case, to act only with an eye single to the benefit of his patient, and the glory of his profession, he is not worthy of the name which he bears, or fit for the discharge of the solemn duties which he assumes. In a word, such an operator is not to be trusted, for he will be certain, whenever opportunity offers, to employ the knife rather for the temporary eclat which may follow its use, than for the good of the individual whom he unnecessarily tortures. He will not hesitate to amputate a limb, although the patient should die the moment he is removed from the table, or to tie the carotid artery for a malignant disease of the eye, although he knows full well that such a procedure never has, in any instance, been of the slightest benefit. Such men, of whom there are, even yet, unfortunately, too many in our profession, deserve the name of knivesmen and knaves rather than of surgeons and honest men. No operation should ever be undertaken without due deliberation, and without a careful consideration of the various consequences involved in the result. Everything that is done should be done with reference exclusively to the patient; self should not have the slighest weight in the matter. The question, in every case, should be, is an operation necessary to save life, or to place the individual in a condition calculated to promote and insure his recovery? If this can be answered affirmatively, the operation should by all means be proceeded with; but if it be ascertained, clearly and satisfactorily, that it presents no such prospect, both humanity and common sense dictate the propriety of declining it. It is a sad and humiliating spectacle to see a surgeon cut off a limb, or remove a carcinomatous tumor, merely for the sake of having it said that he performed an operation. The conscientious and enlightened surgeon, unlike the heartless soldier, carefully respects life; he regards life as a great boon, and uses every possible endeavor to preserve and to prolong it. " I have been reared," said Napoleon, " on battle-fields, and such a man as I am makes no account of a million of men's lives."

No surgeon can be a skilful operator unless he has a thorough knowledge of anatomy. His acquaintance with the healthy structures and their relations with each other should be so clear and distinct that he should be able to see them as it were in a mirror, or with his eyes shut. He should carefully study their color and consistence, that, seeing and feeling them, he may readily distinguish them from each other, and not be obliged to ask his assistants whether this is an artery, that a nerve, or this a tendon, a muscle, or a ligament. Nor should he limit himself merely to the study of healthy and relative anatomy. He should also have an intimate and comprehensive knowledge of morbid anatomy, or of the changes which are impressed upon the organs and tissues by disease and accident, and also of the various growths, formations, and deposits. The information thus derived will be of the greatest aid in facilitating the different steps of the operation, and in enabling the surgeon to determine what to remove and what to spare.

No man can become an accomplished operator unless he practices constantly on the dead subject. Dexterity, grace, and elegance are to be acquired only by long and patient exercise. In all operations involving unusual anatomical complexity, a good plan is to make a thorough dissection of the parts immediately beforehand. Langenbeck, Lisfranc, Cooper, and Mott always adopted this method, and I have often profited by it in my own practice.

Preparation of the Patient.—No operation, unless it be of the most trivial nature, should ever be attempted without due preparation of the patient's system. The only exception to this rule is in case of emergency, where, in order to save life, we are obliged to act on the instant, without any precaution of this kind, and sometimes even without the necessary assistance. The character and amount of the preliminary treatment must, of course, vary in different cases and under different circumstances, and do not, therefore, admit of precise specification. It may be stated, in general terms, that, even if the patient be unusually plethoric, it will rarely be necessary to bleed him at the arm. In operations about the head, eye, and throat, this may be a wise precaution, but in most other situations this is uncalled for. In all instances it is well to take into the account the probable loss of blood that may take place during the operation. If this is likely to be considerable, all preliminary abstraction must be carefully refrained from, even in healthy, robust subjects; for there can be no doubt whatever that a copious, or even a considerable, loss of blood before, during, or immediately after an operation, has a marked tendency, in many cases, to retard recovery, and to dispose to the occurrence of erysipelas, pyemia,

tetanus, and other ill effects. Indeed, so thoroughly am I convinced of the truth of this remark that I feel as if it could not be urged too forcibly upon the mind of the practitioner. It was formerly thought that a certain amount of hemorrhage, under such circumstances, would not only do no harm, but that it would positively be beneficial, by rendering the system less liable to inflammation. Modern experience, however, has shown that such an opinion is utterly untenable.

In regard to the use of *laxatives* and purgatives, much judgment is required. While in many cases this class of remedies may be entirely dispensed with during the preliminary treatment, in others their exhibition is imperatively demanded. Their employment is especially indicated when the bowels are in an overloaded condition, or when there is some derangement of the secretion of the salivary glands, the liver, and mucous follicles of the alimentary canal, as denoted by the fetid state of the breath, the dryness of the mouth, the want of appetite, nausea, vomiting, or headache, or other other symptoms of malaise. The best articles for this purpose are blue mass and colocynth, or calomel and rhubarb, either alone, or in union with a small quantity of ipecacuanha or tartar emetic. The latter substances are especially valuable when there is much disorder of the secretions, with headache and loss of appetite. Occasionally nothing answers better than, or hardly as well as, a dose of castor oil, Epsom salt, or citrate of magnesium. Independently of their direct cathartic effect, purgatives are often extremely useful in clearing out the bowels, when, as, for example, in lithotomy and in anal fistule, it is desirable to prevent any action upon them for several days after the operation.

A proper regulation of the *diet* is generally of paramount importance. The extent to which this should be carried must, of course, depend upon the circumstances of each particular case ; but, as a rule, should not, on the one hand, be too rigid or protracted, and, on the other, not too abundant. Much of the success of an operation is often directly traceable to the attention that is bestowed upon this subject. In general it will be advisable to enjoin entire abstinence from meat and the coarser kinds of vegetables, coffee and strong tea, hot biscuit, pastry, condiments, and, in short, all articles of an indigestible and heating nature. The quantity of food taken in the twenty-four hours should also be less than ordinary, for nearly, if not quite, as much harm may result from an undue amount of mild and unstimulant food as from the moderate use of the more solid and substantial articles.

Instead of dieting and purging the patient, it may be necessary to feed and stimulate him before it is safe to use the knife. He may be exhausted, deficient in nerve-power, or pale and anemic, requiring a rich, concentrated animal, or mixed diet, milk, brandy, ale, or porter, and, perhaps, quinine and iron, especially the tincture of the chloride. Such a course is particularly indicated when there is a tendency to epidemic disease, lest the patient, from shock and loss of blood, should fall a ready prey to its effects. The employment of quinine is generally of immense benefit in all severe injuries, whether accidentally or designedly inflicted, in preventing erysipelas, phlebitis, angeioleucitis, septicemia, pyemia, and kindred affections, and in promoting recovery. This treatment is especially called for in persons living in, or coming from, malarial regions of country.

Finally, attention should be paid to the state of the body and *mind*. For some days, or even, perhaps, an entire week, the most perfect quietude should be observed, especially if the operation is at all likely to be of a serious character. If, for example, the object is to extract a foreign substance from the knee-joint, or to perform an operation for the radical cure of varicose enlargement of the veins of the leg, it is hardly possible to use too much caution in this respect. In such cases the patient should not only refrain from exercise, but remain recumbent much longer than usual, with the limb in an elevated, relaxed position. In ordinary cases a few days' confinement to the house will be quite sufficient.

Tranquillity of mind is a matter of great moment. All business cares should be laid aside, and no outward troubles of any kind be permitted to obtrude themselves during this probationary period. No unpleasant forebodings concerning the result of the operation should be indulged in ; or, if this be inevitable, the surgeon should exert himself to the utmost to assuage and mitigate them by proper explanations. In a word, it is his duty, in all cases, to encourage the timid and console the desponding by every means in his power. Many of our patients are from abroad, away from home and friends, and, therefore, peculiarly in need of sympathy.

Nothing depresses the powers of life more injuriously, or interferes more effectually with the reparative process than fear. It lowers the heart's action, disorders the secretions, and not unfrequently leads to the worst results. We now and then meet with a patient

who labors under an undefined apprehension that the operation to which he is about to submit will prove fatal. Every argument that the surgeon can employ fails to convince him; the impression is firmly fixed in his mind, and, if he does not die, his convalescence is sure to be tedious, and, for a long time, unsatisfactory. I never approach such a case without serious misgivings as to its final issue, and I question whether it would not be well, in such a condition, to refrain from the use of the knife altogether, at least for a time.

The influence of fear in depressing the vital powers is well illustrated in a case that occurred, in 1866, in the practice of Cazenave, of Bordeaux, in a man sixty years of age, who was about to undergo the bilateral operation of lithotomy. The surgeon was on the point of introducing the staff, when the patient, who had exhibited entire calmness and serenity during the preparations, was observed to become pale and faint, and in the course of ten minutes, in spite of all that was done, he expired. When this nervous syncope seized him, the instrument had not yet even touched him. A case of a similar nature occurred to Desault. An old man, suspected to be laboring under stone in the bladder, was about to be sounded by Civiale, but died of terror almost before the instrument had touched the meatus. Perrin refers to the case of a soldier, twenty-five years of age, affected with phimosis, who, reluctantly consenting to an operation, no sooner saw the surgeon's knife than he fell into a syncope and instantly expired.

The sudden supervention of grief, after a severe operation, often gravely complicates the case, by weakening, if not completely destroying, the efforts at restoration. The loss of a relative may, in such an event, unexpectedly cost a patient his life. The shock occasioned by the mental despondency violently depresses the system; the wound at once assumes an unhealthy aspect; the adhesive action is arrested; and gangrene, pyemia, or erysipelas finishes the work.

Anger operates in a similar manner. It disturbs the various functions of the body, especially those of the liver, and frequently destroys the process of repair, devitalizing the plasma that is effused between the opposed surfaces, and causing an amount of inflammation altogether incompatible with adhesive action.

Nostalgia is a powerful depressant; and in case of an operation, may, if not speedily relieved, exert a fatal effect. I am sure that I lost from this cause, in 1878, a child eleven years old, from whom I had removed sixteen days previously a small sequester from the lower part of the femur. The operation, performed under the influence of ether, was almost bloodless, and everything went on well during the first week, except that the child was terribly homesick, when gradually arachnitis showed itself, causing death at the end of nine days.

I have never put off an operation on account of the particular season of the year. When it is recollected that the gravest accidents, requiring amputation, occur every hour of the day, and every day of the year, such a precaution would seem to be entirely at variance with common sense, if not wholly useless. Nevertheless, I should certainly not advise the undertaking of any serious operation in extremely hot weather, if it were possible to postpone it without detriment to the patient. The same objection, however, does not lie against very cold weather, inasmuch as a good fire and a properly regulated temperature of the apartment may generally be obtained, without much trouble, even in midwinter and in the most rigorous climate.

No operation, even of the most trivial nature, unless imperatively demanded, should be performed during the prevalence of an *epidemic*. This remark is particularly applicable to erysipelas, which, under such circumstances, is almost sure to ingraft itself upon the wound, much to the detriment both of the part and system. During an epidemic of this kind in Kentucky in 1845, '46, and '47, the slightest abrasion of the skin, a leech-bite, or the application of a blister, was often followed by an obstinate, and sometimes even a fatal, attack of the disease; and the consequence was that I was compelled, for many months, to decline the use of the knife nearly altogether.

Age is, as a general rule, no barrier to an operation. Even infants at the breast have occasionally undergone the operation of lithotomy, and in certain congenital affections, as occlusion of the anus and urethra, the knife is obliged to be used almost immediately after birth. I am, however, as will be stated in its proper place, no advocate for very early interference in harelip; and I am clearly of opinion that it is best, as a general rule, to put off all severe operations in infants as long as possible, for it cannot be denied that they bear the shock and loss of blood, consequent upon such undertakings, much worse than persons of riper years and more developed constitutions. Very old people

often bear operations remarkably well, and recover from their effects with surprising facility. Pregnancy should always be considered as a bar to the use of the knife, except in those cases in which it is imperatively demanded to save life. Even the extraction of a tooth is occasionally followed by abortion or miscarriage, from the perturbating influence which it exerts upon the system.

The *habits* of the patient should not be disregarded in considering the question as to the propriety or impropriety of operative interference, for there can be no doubt that they frequently materially influence the result. Intemperance of every description, especially if long continued, always modifies the constitution, and renders it less able, as a general rule, to bear the shock and subsequent effects of the operation than in ordinary cases. In habitual drunkards mania à potu, erysipelas, and unhealthy suppuration are of frequent occurrence after the use of the knife. Huge feeders, or persons who are fond of the pleasures of the table, and who take little exercise in the open air, are scarcely less exempt from these affections. Inordinate sexual indulgence, the habitual loss of blood, and debility from previous suffering, often place the life of the patient in danger after a severe operation. Fat persons, and individuals of a doughy, inelastic constitution, do not bear the knife so well as the fleshy and more robust. The same is true, only in a still greater degree, of strumous people. Nervous, hysterical females are bad subjects for severe operations. Hospital patients, especially in the larger cities, do not, as a general rule, possess the same tolerance of the knife as private patients.

Should females be subjected to operations during the *menstrual* period, or immediately before its occurrence? Of the impropriety of such a course there can, as a general rule, be no doubt, and yet there may be exceptions even here. Certainly no sensible surgeon would extract a cataract at such a time, or remove a diseased mamma; or, in short, perform any serious operation, if it could possibly be postponed. But, on the other hand, daily observation teaches that women who are badly hurt during the menstrual period often make most excellent recoveries. I should, therefore, deem it perfectly proper to perform at least any of the minor operations at this time, and, in fact, almost any other where delay might prove prejudicial.

There are certain *diseases*, even some of which are not of a malignant character, in which surgical interference is wholly inadmissible, either for the time being, or altogether. I allude to those cases in which the malady demanding operation is complicated with other affections. Thus, in anal fistule, associated with tubercular phthisis, the knife should certainly not be used, unless the case is of an unusually distressing nature. The disease, in such a case, may be regarded as nature's issue, the drying up of which would almost be sure to be followed by an aggravation of the pulmonary symptoms. In stone of the bladder no one operates when there is serious organic disease of the kidneys, or even of the bladder itself. Amputation of a limb is never performed, except in cases of accident, when there is an aneurism of the heart; nor is the femoral artery ever tied for popliteal aneurism when a similar affection exists in the arch of the aorta. Persons laboring under diabetes do not bear operations well; their vital powers are always greatly depressed by the disease, and they are very liable to sink rapidly under injury, especially if attended with shock, or shock and loss of blood.

Persons affected with jaundice are bad subjects for operation. The blood, under such circumstances, is unusually dark, oozes freely from the cut surface, and is indisposed to coagulate. Besides, the adhesive process rarely advances kindly when the system is in this condition; the stomach and bowels are not easily regulated; and the slightest shock or hemorrhage may be followed by pyemia.

Indiscriminate operations cannot be too severely condemned, as they are injurious alike to the patient, the reputation of the surgeon, and the true interests of science. Like a prudent general, the surgeon should know when to retreat as well as when to advance. It is difficult to conceive of anything more laudable than a bold undertaking in a case which must prove fatal without speedy relief. At the same time, it would certainly indicate a degree of weakness, it not of absolute wickedness, to attempt an operation when there is not the slightest prospect of benefit.

There is a class of operations to which the French writers have applied the term *complaisance*, that is, operations of expediency, not of necessity. An individual, for example, has an infirmity, as a distorted foot, or a contracted finger, which is a source of annoyance rather than of suffering or even positive inconvenience; his pride is piqued, and as a consequence his mind is so incessantly disturbed by it as, perhaps, to be wholly disqualified

for business and social enjoyment. Such persons often importune the surgeon's aid, and it, therefore, becomes a nice question how he should govern himself. Shall he advise an operation, and run the risk of destroying his patient, or shall he refrain, and persuade him to bear his cross, for such it actually is? There can, I think, in general, be very little difficulty in arriving at a proper conclusion in such a state of things. For myself, I can see no difference between the physical suffering that is induced by a diseased bone and the mental distress that results from a deformed foot; so far as their effect upon the comfort and happiness of the individual is concerned they are precisely on the same level, and hence, if it be right and proper to amputate in the one case, why should it not be in the other? If a young man has a varicocele, even of moderate size, and it completely destroys his happiness and usefulness, not by its physical but by its mental effects, is it not our solemn duty to attempt relief by an operation, although the attempt should jeopard his life? I must confess, I should not hesitate as to the line of conduct to be pursued under the circumstances; at the same time, however, I should not omit to warn my patient of the risk he would be likely to run, and if, after a thorough explanation of the whole matter, he should still persist in his desire to be operated on, I should use every possible precaution, by a course of diet, rest, and other means, to put his system in the best possible condition for sustaining the shock of the approaching ordeal. Operations involving the same principle, although not the same risk, are of daily occurrence, and few surgeons hesitate to perform them: I allude more especially to the division of tendons in club-foot and strabismus, the extraction of the crystalline lens in cataract of one eye, when the other eye is sound, and other analogous affections.

Are double *synchronous* operations, or operations performed in immediate succession, justifiable? There can be no hesitation in answering this question affirmatively when the case is a comparatively simple one, as, for instance, when a man has several sebaceous tumors upon the scalp, or two or three small fatty tumors upon his back and shoulder. Here there could certainly be no impropriety, provided the system is in a sound condition, in extirpating all the morbid growths at one sitting. A similar course would be very proper if a hydrocele coexisted with a phimosis, a club-foot with a strabismus, a hemorrhoid with a polyp of the rectum. Even synchronous amputations are not unfrequently performed, and, occasionally, with the most happy results. A thigh has sometimes been cut off, and a skull trephined, at one sitting. Nevertheless, it is a good rule, one, indeed, which should seldom, if ever, be violated, not to perform two severe operations simultaneously or in rapid succession, if it be possible to avoid it, inasmuch as the shock and loss of blood thus entailed might be followed by fatal collapse or destructive inflammation. The rule is particularly applicable to chronic cases; in injuries, on the contrary, as gunshot wounds, railway accidents, and compound fractures, the surgeon may have no choice, as delay may then be altogether out of the question.

Assistants.—There are few operations which a surgeon can perform alone; in general, he is obliged to have assistants, and the number of these must necessarily vary in different cases and under different circumstances. Sometimes only one is required; at other times two, three, four, or even half a dozen will hardly suffice. The more simple an operation the less aid will commonly be necessary. In lithotomy an assistant holds the staff, two others support each a leg, one administers chloroform, another takes charge of the patient's hands, and a sixth presents the surgeon his instruments. In extracting a cataract, the operator usually requires only one assistant, to support the head and upper eyelid. Operations on children, especially when we are not permitted to employ anaesthetics, are often peculiarly embarrassing, and demand an unusual amount of aid for their successful execution.

The beauty, elegance, and rapidity, nay even the success of an operation, are often marred by the awkwardness of the assistants. To act well their part, they should be thoroughly acquainted with the different steps of the operation which is about to be performed, as well as with the nature and relations of the structures involved in it, so as to be able to anticipate every thought and wish of the principal. It is not necessary that they should be compelled, like so many Thespians, to rehearse the part which they are expected to play in the approaching task; but they should be thoroughly instructed in their business, and perfectly understand their duty, which should always be carefully explained and assigned beforehand. Nothing can be more awkward for a surgeon than to stop in the midst of an operation to ask for a knife, sponge, or ligature; once begun, everything should proceed with the utmost regularity, and without the slightest interruption from any cause. Good, well-trained assistants are, unfortunately, not always to be obtained; the older members of the profession are too much occupied to afford their

services, and the younger are too often ignorant of the duties required of them. These obstacles to success are usually much less in hospital than in private practice.

Duty of the Surgeon.—When the surgeon has perfect control of his time, as he almost always may have, except in cases of emergency, he generally selects a particular hour for performing the operation. The best period of the day, at least in this country, is from 11 to 3 o'clock, as he will then have the advantage of a good light, and also be in better trim for the discharge of his duty. An operation, especially an important one, should never, as a matter of choice, be performed late in the afternoon, or in cloudy weather; for, should hemorrhage arise, it might be very difficult to arrest it, on account of the want of good light, so indispensable on such occasions.

Artificial light may sometimes be used to great advantage in certain operations; and occasionally the aid of reflected light, as when it is thrown from the mirror of an ophthalmoscope, is of great service, especially in deep wounds, as those made in lithotomy, the ligation of the innominate and subclavian arteries, and the extirpation of tumors of the neck.

At the hour specified for the operation everything should be in its place; the assistants should attend with military punctuality; the table should be properly prepared; the anæsthetics, ammonia, and brandy, instruments, ligatures, sponges, water, and towels, should all be at the precise spot where they are required; in short, nothing should be wanting, but everything be at hand, and arranged in the most perfect order. I have heard of a surgeon, engaged in an amputation, making his flaps, and asking for his saw, which had been left in an adjoining room! A lithotomist performed the lateral section, and was about to introduce the forceps to extract the stone, when, lo and behold, the instrument had not been put on the tray! Such blunders might create a smile, if they did not sometimes involve serious consequences. It need hardly be added that all these preparations should be made in an adjoining room, away from the patient; it is enough for him to know that he is about to suffer, without seeing the instruments of his torture deliberately spread out, one after another, before his eyes. "The best general," said one of the greatest who ever lived, "is he who makes the fewest mistakes. Victory does not necessarily crown the best devised plan, but the want of one is almost certain to entail defeat."

Of the precise time, as to the day and hour, of the operation, the patient should usually be kept in ignorance, as the information, if made, could hardly fail to exert a perturbating, and, consequently, a prejudicial, influence upon the mind, and, through it, upon the general system. It is only in the milder cases that this intelligence should be communicated. There is, however, much difference in this respect in different individuals; for, while some would shrink from the disclosure, and be, perhaps, seriously affected by it, others will not only be indifferent to, but absolutely court it.

Position of the Patient and Surgeon.—The position of the patient, the surgeon, and the assistants must vary, of course, in different cases, and can be discussed here only in a general manner. When chloroform is to be given, absolute recumbency is required, to guard not only against delay, but also against the occurrence of serious mishaps. But, apart from this consideration, the horizontal posture should always be preferred whenever the operation is likely to be protracted, or attended with much shock and loss of blood. In other cases, again, as in lithotomy, the operation cannot be performed in any other posture than in the recumbent. In amputating the thigh and leg, as well, indeed, as the arm and forearm, the patient always lies down, not only on account of apprehended weakness, but because it is always easier, when he is thus placed, to hold the limb and control hemorrhage. In lacerating a cataract, the patient generally sits in a chair, with his head supported upon the breast of an assistant; in operating on harelip, the child usually sits upon an assistant's lap, the head being firmly held by another assistant, standing behind or by the side of the first. In lithotomy, the patient lies on his back, with the breech projecting over the edge of the table: two assistants support the legs, another holds the staff, a fourth takes charge of the sponges, and a fifth administers chloroform, while the surgeon sits on a low stool in front of the perineum, or, as I usually prefer, rests on one of his knees. Now that anæsthetics are so much in vogue, it is seldom that we are obliged to tie our patients, or to roll them up in sheets or aprons, as was the custom prior to the discovery of these agents.

The more important operations are generally most conveniently performed upon a firm, narrow breakfast table, well covered with blankets or comforts. Several pillows and folded sheets, and, if the case is likely to be a bloody one, a piece of soft oil-cloth, should be at hand, with a tray filled with sand or sawdust, to receive the discharges. Sometimes a lounge or sofa may conveniently be used; and, in many instances, the edge of the bed

answers very well. The patient should have as few clothes on as possible, for two reasons: first, that his dress may not be unnecessarily soiled, and, secondly, because it will afford him more freedom in breathing.

The surgeon and his aids should be careful, during the operation, that they do not, on the one hand, inoculate themselves with the discharges of the patient, and, on the other, that they do not communicate disease to him through their own persons, as might readily happen if they have recently been engaged in the dissection of patients dead of erysipelas, phlebitis, pyemia, or diffuse inflammation, especially of the peritoneum and of the pelvic veins of lying-in females. That there is frequently, if not generally, a virulent poison present in these affections, the influence of which may readily be disseminated by means of the hands and clothes, is fully established, and, therefore, every possible care should be taken to guard against all such contingencies. Accoucheurs often communicate disease and death in this manner from one parturient woman to another, and there are few practitioners extensively engaged in operative surgery, whether in private or public, who have not had similar experience among their own patients. A number of cases have been recorded in which surgeons in amputating limbs and excising tumors have contracted fatal diseases by the inoculation of their hands. In performing any delicate operation the hands should always be well washed and the finger nails thoroughly cleaned as a preliminary measure, in order that no dirt or perspiration may be deposited upon the wound, and thus become a source of irritation, interfering with the reparative process.

OPERATION.—Everything being thus prepared—the assistants being at their posts, the instruments arranged upon a tray in the order in which they are likely to be required, the parts divested of hair and dressings, and the patient fully under the influence of an anæsthetic—the operation is proceeded with, slowly, deliberately, and in the most orderly, quiet, and dignified manner. All display, as such, is studiously avoided; ever remembering, in the language of Desault, that the simplicity of an operation is the measure of its perfection. No talking or whispering should be permitted on the part of the assistants, and, as to laughter, nothing could be in worse taste, or more deserving of rebuke. Every important operation should be looked upon as a solemn undertaking, which may be followed in an instant by the death of a human being, whose life, on such an occasion, is often literally suspended by a thread, which the most trivial accident may serve to snap asunder.

The time occupied in performing an operation is a matter of some moment, but not so much, perhaps, as is commonly supposed. When a patient is unconscious, whether from cerebral oppression, or from the use of an anæsthetic agent, it is of very little consequence, other things being equal, whether the operation lasts five minutes or ten minutes, provided it is well executed, which it certainly cannot always be when we aim at great speed. Le Cat, it is said, lithotomized half a dozen patients in nearly twice as many minutes, and the result was that he lost nearly every one. Prior to the application of anæsthetics to the relief of suffering, rapidity was most commendable, inasmuch as it served to prevent shock and pain, although I am well convinced that it was often secured at the expense of much subsequent mischief, if not immediate detriment. The maxim of the schools has always been *cito, tuto et jucunde:* but, as it respects the first of these injunctions, it may be added, in the language of Cato, *sat cito si sat bene.*

Accidents during Operation.—The next topics to be considered are the accidents which are liable to take place during the operation, and the best methods of avoiding or meeting them. These are, first, hemorrhage, and, secondly, shock.

The amount of blood lost during an operation may be very small when measured by ounces, but very large in relation to its effects upon the system. Much will depend, in every case, upon the state of the constitution, and the temperament, habits, and health of the patient. A hemorrhage which may affect one individual very slightly, if, indeed, at all, may affect another most seriously and even fatally. A good deal, again, will depend upon mere idiosyncrasy, and upon the presence or absence of epidemic disease, which, as has already been intimated, generally impresses itself, to a greater or less extent, upon every individual in the community in which such disease prevails. Anything like a copious loss of blood is, as before stated, a great evil, and should, therefore, always if possible, be prevented. I cannot agree with those who think that the loss of twelve, sixteen, or twenty ounces will be likely to be beneficial, even when there is unusual vigor of constitution. If there be any undue vascular repletion, it can always be relieved, if the necessity arises, after the operation is over. In all cases, therefore, I deem it to be our duty to guard against hemorrhage as much as possible.

In amputations, the removal of necrosed or carious bone, the excision of bones and

joints, the extirpation of morbid growths, and all other surgical procedures upon the extremities, the field of operation may be rendered perfectly bloodless by the use of Esmarch's apparatus, which, as represented in figs. 204, 205, consists of an elastic bandage and an elastic flat band, the latter being preferable to the rubber tubing originally
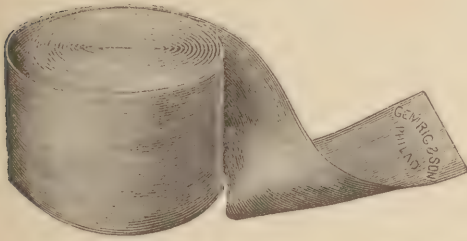
Fig. 204.   Fig. 205.
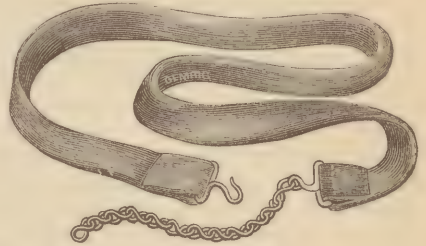
Esmarch's Apparatus.

employed for constricting the limb above the last turn of the bandage. The bandage is applied by spiral turns, commencing at the toes or fingers, and when a sufficiency of the extremity has been covered, the band is wound rather firmly several times round the limb, and secured by the hook and chain. When the bandage is removed, the necessary incisions can be made without the loss of blood. Before the use of the compressing band, the constriction excited by the rubber cord was not infrequently followed by sloughing of the edges of the wound, but I have not met with examples of a similar nature since I have resorted to the former contrivance. If the band be too firmly applied it paralyzes the vasomotor nerves of the part, so that, after its removal, and the ligation of the principal arteries, there is free and prolonged bleeding from the smaller branches, thus leading to the necessity of employing a much larger number of ligatures than when the operation is performed according to the old method. Even when the constriction is merely sufficient to arrest the circulation in the limb, there is always pretty free capillary oozing, for the control of which Esmarch relies upon elevating the limb before the band is removed, as well as for half an hour after the wound has been dressed; Riedinger, to produce a similar effect, applies the faradic current to the wound. I myself have never had occasion to resort to these annoying and troublesome measures, as I have always found that the parenchymatous hemorrhage is readily controlled by retaining a cloth or sponge wrung out of water at a temperature of 110° to 115° Fahr. in the wound, and afterwards loosening the band very slowly. In operations for necrosis the bleeding is readily arrested by stuffing the wound with oiled lint before the band is removed. An ordinary bandage and tourniquet, such as I have used for the last forty years, in all my larger amputations, will, if properly applied, empty the vessels sufficiently for all practical purposes, and effectually protect the parts from this reaction, always so trying to the surgeon, if not fraught with danger to the patient. This method of preventing hemorrhage is contraindicated when a limb is the seat of gangrene or of collections of septic fluids, which might be pressed into the veins and lymphatic vessels and thus carried into the mass of circulating blood.

When the apparatus of Esmarch is not used, it is not necessary, or even proper, to tie every vessel as fast as it is divided. A well-trained assistant will generally obviate this necessity by compressing the bleeding orifice the moment the knife has swept beyond it, and by the proper exercise of this dexterity a large tumor may often be removed before a single ligature is applied. If the bleeding, however, be not controllable by this means, measures must be adopted to arrest it without delay by ligating the principal vessels from which it proceeds.

It is seldom, at the present day, that a patient sustains anything like serious shock from an operation, even if it be comparatively severe and protracted. The use of anæsthetics, if it do not always effectually prevent, generally restricts it within the limits of tolerance, and thus saves the surgeon a vast amount of trouble and anxiety. It is not, however, to be forgotten that the very means which are employed to prevent pain and shock may themselves induce severe, if not fatal, prostration. Hence, as will be seen by and by, too much caution cannot be used in their administration, the effects of the remedy being most carefully watched throughout, so that any symptom denotive of danger may instantly be recognized and counteracted. By keeping the patient perfectly recumbent

and providing for the free admission of air into the lungs, all mischief may, in general, be happily avoided. The syncope, caused by the loss of blood, is met by a depressed position of the head, by means of the fan, by dashing cold water upon the face and chest, by holding smelling-bottles near the nose, and, in severe and alarming cases, by sinapisms to the extremities, spine, and precordial region, aided, if necessary, by the use of stimulating injections, as brandy, turpentine, ammonia, or mustard.

Dressings and After-Treatment.—The operation being over, the next thing to be done is to adjust the dressings; these should always be as light as possible, and applied in such a manner as to insure the greatest chance for union by the first intention. The question has been much agitated, of late years, whether the dressings should be applied at once, the moment the knife has accomplished its object, or whether the parts should be permitted to remain free for several hours, to afford them an opportunity of contracting and becoming glazed with plastic matter. Much might be said in favor of both methods. The proper rule of practice, I think, is to steer a middle course, adopting neither plan exclusively. In large wounds, as those, for example, left in amputations of the thigh, leg, or arm, and in the extirpation of large tumors, the best plan always is to keep the parts open for three, four, or five hours, or until all oozing has ceased, and the raw surface has become incrusted with plastic matter, a light, porous towel, properly folded and frequently wrung out of cold water, being kept constantly applied to promote these occurrences. If, under such circumstances, approximation be effected immediately after the operation, the surgeon will often be compelled, a short time afterwards, even when he has taken the greatest possible care to secure the vessels, to remove his dressings, in order to arrest the flow of blood; a procedure which is generally not less painful and alarming to the patient than disagreeable and vexatious to the attendant. If, on the other hand, the wound is small, the best plan, I conceive, is to bring the edges together at once, as this saves both time and anxiety.

The dressings being applied, the patient is carried into his bed, previously prepared for his accommodation, and placed in such a position as will best promote his comfort and the reunion of the divided parts. Feathers and heavy quilts are to be carefully avoided; and, in general, it will be well, especially if there is a probability of there being much discharge, whether of blood, secretion, or excretion, to protect the bedding with a piece of thin, soft oil-cloth, spread beneath a folded, movable sheet. The affected parts are placed in an elevated and relaxed position, and maintained, throughout, in a cool, comfortable state. The diet must be light and unirritant, the drink cooling and palatable, and the temperature of the apartment from 65° to 72° Fahr. All unnecessary conversation should be avoided; and no persons, except the nurse and the immediate friends of the patient, should be permitted to enter the room during the first twenty-four hours after the operation, or, in cases of great danger and severity, not until a much longer time.

When an operation is performed in private, in the patient's own room, or in the apartment which he is afterwards to occupy, all extraneous material, as the table, sheets, towels, basins, and cloths, should be removed as speedily as possible after the work is over, and everything set in proper order, so that the patient, when he wakes from the effects of the anæsthetic, may find nothing, as he casts his eyes around him, to shock his feelings or offend his taste. It is impossible to bestow too much attention upon the æsthetics of the sick-room.

When the operation is at all severe, my invariable rule is to administer a full anodyne, generally a fourth or a third of a grain of morphia hypodermically immediately after it is over, or even sometimes an hour or two before it is commenced. The object is not only to allay pain, which is always a great desideratum, but to induce sleep and tranquillity of the system; in other words, to put the part, body and mind, all in a state of absolute repose for at least the first twenty-four hours after the use of the knife. By a full dose of morphia, I mean not less than one-third of a grain; a smaller quantity than this would only serve to fret and worry the patient instead of composing him. In cases of unusual severity, I do not hesitate to give half or even two-thirds of a grain, never forgetting that excessive suffering always establishes a certain amount of tolerance to the use of anodynes.

Too much attention cannot be bestowed upon the patient's diet. If the operation has been at all severe, or attended with unusual shock and loss of blood, he must be fed, not starved, in order to enable the system to reinstate itself as promptly as possible into its former condition, by the manufacture of blood and nervous fluid, both, perhaps, frightfully expended during the previous contest, and now in danger of being still further exhausted by the traumatic fever and the tumultuous action of the heart. The vessels must be

replenished; the brain and spinal cord supported. The most suitable articles for this purpose are milk and stale bread, with the free use of brandy, followed, in a day or two, by animal broths, beef essence, rich soups, and the lighter kinds of meats. Subacid fruits will also generally prove both grateful and nourishing. The drink should consist of iced water, either pure or acidulated, as may be most agreeable to the patient. A cup of tea or coffee is often exceedingly soothing and refreshing soon after a severe operation. Starvation after violent shock and loss of blood is frequently followed by the worst consequences, from the tendency in the system to run into erysipelas, pyemia, and hectic fever, independently of its incompatibility with the adhesive process.

The effects of diet upon mortality after injuries and operations are well illustrated by what occurred among the wounded soldiers that were received in the different hospitals of Paris in 1814. The table, drawn up by Malgaigne, included French, Prussians, Austrians, and Russians, the latter of whom had a liberal allowance of bread, vegetables, meat, wine, and even brandy, while the others were subjected to a strict dietetic regimen. The mortality among the French soldiers was 1 in 7, of the Prussian 1 in 9, of the Austrian 1 in 12, and of the Russian 1 in 27; an astonishing difference if we assume, as we are authorized, that it was due solely to a difference of treatment, and not to any peculiarity in the nature of the wounds, the surgical treatment, or the air of the hospitals in which the soldiers were accommodated.

But patients must not be fed indiscriminately after operations; when the individual is young and robust, perfectly temperate in his habits, and, above all, when he has not suffered severely from shock or loss of blood, his diet should be restricted and of the blandest character for a number of days, or, in fact, until the wound left by the knife is in great measure healed. Improper indulgence, under such circumstances, cannot fail to light up a fire which hardly anything afterwards may be able to extinguish.

If the patient has sustained severe shock or loss of blood, he should not only be well fed from the very beginning, but promptly subjected to the use of tincture of chloride of iron, in doses varying from twenty to thirty drops every three or four hours, as a preventive of erysipelas and pyemia, so liable to occur under such circumstances. Quinine may often be advantageously conjoined with the chalybeate, especially if the patient has been affected with malarial disease. Anodynes should also be freely exhibited.

Attention to the temperature of the patient's apartment is often a matter of great moment; in general, it will be best to regulate it by the thermometer, especially in operations on the respiratory organs, and after the extirpation of ovarian tumors. Everything like a direct draught must be carefully avoided; and in wet weather it will be well, especially if the moisture of the air be combined with cold, to employ artificial heat, while the doors and windows are sufficiently opened to secure proper ventilation.

The dressings should not be disturbed too soon, or oftener than is absolutely necessary to the comfort of the part and system. As a general rule, they require to be changed more frequently in warm than in cold weather, and in copious than in slight discharge. The proper practice is never to meddle with them so long as they answer the purpose for which they are applied. The sutures and adhesive strips should be removed with the utmost care; the substitute dressings should be prepared and ready for use before the old are taken off; the sponge should be employed with the greatest gentleness; in a word, all rude manipulation should be most studiously avoided. No bandage, however thoroughly washed, should be used twice, as it is liable, from the retention of matter, to become the carrier of infection, especially in large suppurating wounds and in compound fractures and dislocations. For the want of this precaution many a patient has perished from pyemia and erysipelas.

Some of the above precepts may seem trivial; but I am sure that they are of the greatest importance, and that the want of their observance is often followed by the worst consequences. It is a much easier matter to talk a patient to death, or to retard his recovery, after he has undergone a severe operation, or sustained a violent injury, than most people imagine. If symptomatic fever arise, or if the parts exhibit evidence of overaction, prompt recourse must be had to the usual antiphlogistic remedies, employed in a decided yet cautious manner, lest they produce harm instead of good.

The after-treatment should always, if possible, be superintended by the surgeon himself; his duty is not over with the operation; it ceases only with the cure or the death of his patient. "The practice," remarks an eminent authority, "of performing a serious operation, and leaving the after-treatment to others, has, in my knowledge, repeatedly proved disastrous. The medical treatment, a duty not less responsible than the operative, belongs

to the surgeon; and, indeed, to be employed merely as a handicraftsman, conveys an imputation at which the dignity of a scientific mind revolts."

An operation, if well performed, does not, in ordinary cases, require repetition. It is only, as a general rule, where it has been executed in a slovenly and imperfect manner that such a step will be likely to be necessary. Such an error is the more to be deprecated because the repetition of the operation may seriously, if not fatally, compromise the patient's life, after he has successfully surmounted the hazards of the first. If a tumor has been well excised, a limb properly amputated, an artery carefully ligated, there will seldom be any necessity for going over the same ground a second time. If, now and then, the reverse is the case, it only serves as an exception to an important rule. Repetition of an operation is most frequently required in malignant diseases, after lithotomy, and in amputations for the relief of gunshot, railway, and other severe accidents, where the injury often extends much farther up the limb than the eye can discover, and where, consequently, the most enlightened and skilful surgeon may be at fault.

Persons often submit with alacrity to the repetition of an operation when it promises to prolong life, or to afford even temporary relief from suffering; and recovery, under such circumstances, is sometimes very surprising. In a case of recurrent sarcoma of the mammary gland, described in a previous chapter, not less than twenty-three separate operations were performed before a cure was finally brought about. In a case of spindle-celled sarcoma of the neck, I excised the morbid growth five times, at varying intervals, with the effect of prolonging life for upwards of five years. Examples of lithotomy have occurred in which the patient was cut successfully four, five, six, and even seven times, as in the celebrated case of Grangeret.

Sources of Danger after Operations.—The great sources of danger, after a severe operation, are, first, excessive depression of the system from shock and loss of blood; secondly, traumatic fever; thirdly, undue inflammation of the parts; fourthly, secondary hemorrhage; fifthly, erysipelas; sixthly, pyemia; seventhly, tetanus; and, lastly, constitutional irritation.

α. The *prostration*, consequent upon an operation, is usually denoted by great pallor of the countenance, feebleness of the pulse and respiration, coldness of the extremities, yawning and sighing, partial blindness, dizziness, noises in the ears, restlessness, thirst, nausea, and even vomiting. To meet these symptoms, all that is generally necessary is to place the patient recumbent, to use heat, friction, and sinapisms, to allow free access of air, and to administer stimulants, as brandy, or brandy and ammonia, by the mouth, if the power of deglutition still remains, or, if not, by the rectum, in the form of enemata. A full anodyne will usually form a most valuable adjunct to these remedies, and should seldom, if ever, be omitted. Great care, however, must be observed in the management of these cases, lest violent reaction follow the depression, and hurry the patient on to a fatal termination. It is only in instances of extreme prostration that stimulants should be given boldly and freely, and without any regard to consequences in respect to the parts involved in the operation.

β. Great distress is often experienced after operations, especially if unusually severe or protracted, from nausea and vomiting, attended with more or less prostration, and not unfrequently very difficult of management. The exciting causes of this derangement are not always obvious, but in most of the cases that have been under my charge, the trouble was due to the effects of the anæsthetic, taken in excess, either from want of care in its administration, or want of proper coöperation of the patient. Ether, in particular, is liable to produce such effects, often extending over a period of many hours, or even several days. Occasionally the gastric disturbance depends upon the anodynes given to prevent or relieve pain, and promote sleep after the operation; and, in some cases again, it is evidently due to disorder of the secretions brought about by shock and loss of blood. A malarial state of the system, constipation of the bowels, a redundancy of acid or of bile in the stomach, organic disease of the liver or kidneys, and excessive thirst, may be regarded as so many predisposing causes. When the vomiting is very severe or protracted, it may lead to very serious, if not fatal, exhaustion. The treatment must be regulated by the nature of the exciting cause. In my own practice, I have generally found the best remedy to be a hypodermic injection of morphia, with the internal use of ice, and ice applied to the region of the stomach. Chloral and bromide of potassium are also valuable articles; and the use of bicarbonate of sodium in peppermint water is especially indicated when the distress depends upon the presence of acid in the stomach. When the patient is harassed with flatulence, iced champagne often affords prompt relief. Occasionally a mustard emetic answers an excellent purpose, especially in bilious vomiting. Passing a cloth

with a few drops of nitrite of amyl upon it rapidly before the nose, sometimes acts like a charm. In some cases, again, an irritating enema does more good in quieting the stomach than anything else. Now and then the most satisfactory remedy is a large dose of calomel. The best food is milk with lime-water and hot broths, taken in small quantity and frequently repeated.

γ. More or less *fever* must almost necessarily follow every severe operation, offering thus an additional source of suffering and danger to the patient, and of anxiety to the surgeon. To this disease the term traumatic is usually applied; the older writers called it bed or wound fever, and the late Sir James Y. Simpson gave a very excellent account of it under the name of surgical fever.

Fever generally sets in within the first six or eight hours after the operation, and is characterized by a flushed appearance of the face, a frequent, quick, and irritable state of the pulse, elevation of temperature, dryness of the skin, restlessness, and thirst, which is often excessive, especially after profuse losses of blood. In some cases there is extreme jactitation, with nausea, if not actual vomiting, and a tendency to delirium, or a confused and bewildered condition of the intellect. The breathing is generally somewhat hurried, and slight mucous râles are often present. The appetite is impaired or entirely wanting, the bowels are constipated, and the urine is scanty, high-colored, and often offensive, being surcharged with saline matters and occasionally even slightly albuminous. Now and then the disease is ushered in by distinct rigors. After the fever has continued for some time, a tendency to remit appears; the heat, thirst, and restlessness diminish, the pulse and temperature descend, the gastric distress vanishes, and the skin becomes covered with a gentle moisture, which often increases to profuse perspiration.

The duration of traumatic fever varies from a few hours to a number of days. In the milder cases it is generally very evanescent, while in the more severe it is often very protracted, and is then usually attended with regular vesperal, if not also matinal, exacerbations. Not unfrequently the disease disappears entirely for a few days, and then recurs, with more or less violence, the attack being provoked either by some dietetic or other indiscretion on the part of the patient, or by some change of the system, as the arrest of an important secretion, or the commencement of blood-poisoning.

The causes of surgical fever are sufficiently obvious. Every operation of the slightest severity, acts as a disturbing agent, depressing the vital powers, and deranging, as a direct and inevitable consequence, all the secretions. Familiar illustrations of these occurrences are daily met with even in very slight operations, as the lancing of boils, the extraction of teeth, and the abstraction of blood. The least shock, however induced, is sure to be followed by more or less general disorder, and it is hardly necessary to state that the amount of this disorder is always materially augmented when, in addition to the nervous lesion, there has been more or less copious hemorrhage. Nothing so rapidly or so powerfully irritates and frets the vascular and nervous systems as these two circumstances. The heart evinces its suffering first, by the feebleness and irregularity, and, after the occurrence of reaction, by the frequency and rapidity of its contractions. The nausea and vomiting, the excessive prostration, the yawning, and confusion of intellect, not to mention other symptoms, are unmistakable signs of the shock, or loss of power, sustained by the great nervous centres. The use of anæsthetics, doubtless, often contributes to the production of traumatic fever, by the disturbance which it occasions in the general system.

Now, if we take all these circumstances into view, and the fact that thousands of patients are subjected to operations without due preparation of the system, or, indeed, any preparation at all, as in cases of primary amputations, trephining, and the ligation of the larger arteries for the arrest of hemorrhage in gunshot and other wounds, it is certainly not necessary to invoke the agency of blood-poisoning, as is of late so frequently done, to account for the occurrence of traumatic fever. These causes are all sufficient to create the most violent disturbance; or, in other words, to set the whole system in a perfect state of ferment, subverting all its functions, and thus occasioning an amount of reaction capable of destroying life in a few hours, or, at all events, in a few days. While this perturbation is progressing, other and still more serious consequences may ensue, as erysipelas, pyemia, and effusions into the splanchnic cavities, the result of disordered secretion, and of the retention of hurtful matter, eventuating in a diseased state of the blood, and in a predisposition to local inflammation in parts more or less remote from the seat of the original injury. The constitutional derangement will, of course, be materially increased if, in addition to these disturbing agencies, there is an absorption or ingress of foul secretions into the system, constituting septicemia, or blood-poisoning.

The danger in traumatic fever is often very great, and it is, therefore, impossible to

watch the patient too attentively. The risk will be particularly imminent if the disease is very violent, or the system was much prostrated prior to the operation. The danger will then be twofold; first, from constitutional irritation and fatigue of the heart, leading to paralysis of its fibres; and, secondly, from internal congestion and local inflammation.

The proper remedies are cooling drinks, taken in moderation, or ice, if there be nausea, or gastric oppression; sponging the surface with cool or tepid water; mild laxatives; and the neutral mixture, or camphor water, with a minute quantity of antimony and morphia, to promote diaphoresis. If the symptoms are disposed to continue, more active measures may be required, especially purgatives, assisted, perhaps, by a few grains of calomel, particularly when there is marked disorder of the secretions. The lancet can seldom, if ever, be needed in any case. Leeching, cupping, and blistering may be necessary when there is congestion, or impending inflammation, of important internal organs. Local remedies must, of course, not be neglected. If the fever is obstinate, quinine will be indicated, combined, if there be profuse perspiration with a tendency to hectic, with iron and elixir of vitriol. The greatest possible attention is paid to cleanliness and ventilation.

This febrile commotion of the system is sometimes very deceptive, exhibiting an appearance of great violence, when in reality it is most slight, promptly yielding to the most simple remedies, or subsiding of its own accord. It resembles a sudden and violent storm, quite alarming, but altogether transient and harmless.

δ. The resulting *inflammation* will rarely exceed the adhesive limits, if proper care has been taken to prepare the patient for the operation, and the parts have not been too roughly handled during its performance. But prevention is not always possible, and hence the wound should be diligently watched, lest it be assailed, and even overwhelmed before the patient and his attendants are aware of the fact; for it should be remembered that the morbid action is not always characterized, under such circumstances, by the usual symptoms; there may even be an entire absence of pain and tension, perhaps even of discharge. Great vigilance, therefore, is often necessary to detect the earliest inroads of the disease, and to counteract its progress. Of course, all officious interference is avoided, and nature is carefully protected in the maintenance of her rights and privileges. The moment overaction is perceived, the dressings are either removed, or, at all events, slackened, suitable means being substituted. Of these the most important consist of leeches, water-dressings, and cataplasms, either simple or medicated, according to the exigencies of the case. If matter form, free vent is afforded, either by a change of position of the parts, or by puncture and incision. Constitutional treatment, of course, receives due attention.

ε. *Secondary hemorrhage* may come on within a few hours after the adjustment of the parts, or it may be postponed to a later period, even to a few days or weeks. It may be arterial or venous, slight or profuse, transient or persistent, as in the primary form of the accident. The most common causes are, imperfect ligation of the vessels, defective dressing, sloughing, and premature detachment of the ligatures. Whatever they may be, they should be carefully sought out, and at once counteracted by appropriate measures. The occurrence is always to be deprecated, because it has a tendency, not only to alarm the patient and his friends, but to impede and even to prevent the adhesive process, requiring, as it not unfrequently does, the reopening of the wound for its successful management. Fortunately, however, it is, in general, easily avoided, especially if proper attention be paid to the dressings and after-treatment.

ζ. *Erysipelas* is most apt to occur in persons of intemperate habits, or of a broken constitution, and usually makes its appearance within the first three days after the operation, generally at the site of the wound, or in the parts immediately around. Its presence is always denotive of disorder of the digestive apparatus, and hence one of the first things to be done is to administer medicines designed to clear out the bowels and to restore the secretions of the liver, the mucous follicles, and the salivary glands. For this purpose the best articles are calomel and compound extract of colocynth, or blue mass and rhubarb, followed, if necessary, by saline and antimonial preparations, with anodynes to allay pain and procure sleep. When evidence of debility exists, free use must be made of quinine, either alone, or, preferably, of quinine and tincture of chloride of iron, the latter especially being given in large and frequently repeated doses. The local treatment must consist, mainly, of dilute tincture of iodine, and solutions of acetate of lead, with punctures and incisions to relieve tension and afford vent to effused fluids.

η. *Pyemia* may set in almost at any time after an operation, but the most common period is from the third to the eighth day. It is usually ushered in by bold and well-marked symptoms, such as violent rigors alternating with flushes of heat, severe cepha-

lalgia, aching pains in different parts of the body, excessive restlessness, great thirst, a quick and frequent pulse, and inordinate dryness of the cutaneous surface. Delirium and extreme prostration soon ensue, and thus the case progresses from bad to worse, until, frequently in less than a week from the commencement of the attack, the patient expires in a state of utter exhaustion. Little is to be done for a system thus assailed. In nine cases out of ten the disease proves fatal. The proper remedies, at the start, especially if the patient is robust and plethoric, are moderate depletion, especially by leeches, the exhibition of the milder purgatives, as calomel and rhubarb, and mercury with a view to a rapid but gentle constitutional impression. When excessive prostration is threatened, brandy, wine, quinine, iron, and nourishing broths are indicated, and must be administered with a generous hand. Locally, besides leeching, iodine, blisters, and medicated fomentations will be advantageous: if matter form, early and free incisions are made.

g. Tetanus is fortunately a rare occurrence after operations in this country. It is most common in tropical regions. In Europe and North America it is met with chiefly in dissipated persons of a broken, dilapidated constitution. It would seem that in India the operation of lithotomy is occasionally followed by this disease, an effect which, so far as I know, is very seldom, if ever, witnessed in this country. Excessive loss of blood, severe shock, and exposure to currents of air, undoubtedly predispose to the occurrence, which usually shows itself within the first five or six days after the operation. The principal remedies, as indicated in the chapter on tetanus, are, anodynes, in full and sustained doses, atropia, chloral, quinine, iron, brandy, ammonia, and chloroform, with emollient applications to the wounded parts.

ι. Life may be assailed by *constitutional irritation* and profuse discharge, and that, too, long after all apparent danger is over. The patient gradually becomes hectic; his appetite and sleep fail; the bowels are irregular, at one time constipated and at another relaxed; and the parts, exhibiting an unhealthy aspect, refuse to heal. Such a state of things, which, in general, but too surely foreshadows an unfavorable result, is to be combated upon the same principles as hectic produced by ordinary causes.

x. Death sometimes takes place suddenly and unexpectedly after operations without any ascertainable cause, and where, at the time, everything seemed to be in a promising condition as to ultimate recovery. A more sad and distressing occurrence can hardly be imagined, and yet it is one which cannot always be avoided, no matter what precautions may be observed. Mere loss of blood, or shock, is not always sufficient to account for this unfortunate event, although in many instances it doubtless materially contributes to its production; for death not unfrequently happens where no such effects were witnessed. Nor can it be due to the introduction of air into the veins, as, for example, when operations are performed about the neck, inasmuch as, in this case, the patient either perishes instantaneously, or, at any rate, exhibits unmistakable evidence of the accident. Besides, this occurrence is not peculiar to operations upon the cervical region; it has been witnessed in operations upon all parts of the body, even in some of the more insignificant amputations and in the removal of small tumors. When there has been much loss of blood, or severe shock, the event is probably due, at least for the most part, to syncope, or actual paralysis of the heart, preventing this organ from transmitting a sufficiency of blood to the brain for the due performance of its functions; and such an effect is most likely to take place when the patient, through neglect, wilfulness, or mismanagement, sits up in bed, or stands on the floor, thus suddenly depressing the heart's action. In this way life is sometimes instantaneously destroyed in lying-in females, especially in those who have suffered seriously from hemorrhage; and similar results are occasionally witnessed after surgical operations and accidents. In another class of cases, death is probably caused by embolism, that is, by the formation of heart-clots, and of fibrinous concretions in the vessels, impeding the passage of blood, and so arresting, suddenly and unexpectedly, the functions of an important organ. It is well known that copious hemorrhage, or severe shock, invariably renders the blood more coagulable, and hence such a state of the system must be regarded as powerfully predisposing to the occurrence of embolism. It is not improbable that rupture of the heart from fatty degeneration is an occasional cause of sudden death after severe operations, especially when the use of the knife has been attended with inordinate nervous and muscular excitement.

It is sufficient for all practical purposes to know that such an event may occur after operations, without any formal attempt at its solution, which the present state of the science hardly enables us to do. Whatever the cause may be, no efforts should be spared to prevent it. For this purpose, the utmost care should be taken, after all serious operations, not to prop the patient up in bed, or to let him get upon his feet; nay, further, he should not, if he is very weak or exhausted, be permitted to move about in bed, or, in

short, to do anything tending to induce syncope, or promote the occurrence of embolism. The diet should be of a suitable kind, and such medicine should be given as shall have a tendency to impart tone and strength to the system. Free use, in particular, should be made of brandy and milk. If syncope occur, the head must immediately be placed low, and recourse be had to sinapisms and stimulating injections, to reassure the heart, although this will probably be in vain, especially if the cause of the failure of its action is the presence of a clot, either in its own cavities or in some vessel. As it is impossible to foretell, in any given case, when a patient may be exempt from sudden death, after severe shock, or great loss of blood, the precautions here enjoined should be rigidly observed until there is reason to believe that all danger from this cause is passed.

λ. Various *intercurrent diseases* may arise after an operation, and seriously compromise the patient's safety. The poison of an eruptive fever, as, for example, scarlatina may lie in the system in a state of latency before the operation, and after its performance break out in full force, perhaps within the first few days, the shock, hemorrhage, and disordered function contributing to its development, whereas, if no such disturbance had taken place its effects might never have manifested themselves. Malarial affections, supervening upon the use of the knife, often give rise to serious complications, greatly retarding recovery, if not inducing fatal results. A violent attack of dysentery, diarrhœa, gout, rheumatism, pleurisy or pneumonia, is always to be greatly dreaded after any serious surgical operation.

μ. The *mortality* of surgical operations is subject to numerous contingencies, some of which have an intimate relation with the patient himself, some with the nature of the injury, or accident necessitating the interference, and some with the surgeon, either directly or indirectly. It may be assumed, as a general rule, that all the capital operations, as they are termed, are attended with a certain degree of risk to life, while not a few of the minor or more insignificant ones have, from causes which it is not always easy to determine, a fatal issue. A man who undergoes a grave operation is like a soldier who engages in a fierce and bloody battle, with this difference, however, so far as danger is concerned, that, while the one is sure to be severely wounded, the other may escape without the slightest injury. The soldier who serves as a forlorn hope will stand a fair chance of being killed; and so will a patient who submits to the knife on account of some terrible accident or desperate disease. But such cases constitute the exception, not the rule; ordinarily, if the system is properly prepared, and the operation well performed, the surgeon looks with great confidence for a good recovery. If he could always select his cases, the general result would be very different. He would then not employ the knife against his judgment, as a dernier resort, with the certainty that there was hardly one chance out of a hundred for a favorable issue; he would let all the bad, desperate, or unpromising cases alone, to get well or perish, as a kind Providence might direct. But so long as a surgeon has any feelings of humanity he cannot do this; he must take the good, bad, and indifferent cases as they present themselves, and do the best he can with them. It is only when he is guilty of neglect, or of serious mismanagement, that he should be considered culpable. He does not expect to save all; he knows that many must necessarily perish, not so much as an effect of the operation as of the injury or disease for which the operation is performed, and, in attempting to estimate the probable result of his interference, he does not forget to take into the account the risk which his patient is obliged to incur from hemorrhage, erysipelas, pyemia, tetanus, and other intercurrent but often unavoidable affections. He is assured that there is no case, however apparently desperate, that may not recover, or one, however apparently insignificant, that may not perish.

The following tables will serve to show what has hitherto been the mortality after some of the so-called capital operations:—

Operations.	Cases.	Recoveries.	Deaths.	Per cent.
Lithotomy	11,584	10,246	1,338	11.11
Ligation of arteries	1,710	988	722	42.23
Herniotomy	622	326	296	47.57
Amputation of the thigh	2,011	1,150	861	42.80

But these results, so humiliating to surgery, refer chiefly to hospital practice, and can, therefore, hardly be considered as affording a fair average of the experience of the profession in general. The great majority of the most desperate cases, both of injury and disease, in all large towns and cities, find their way into public institutions, where they rapidly sink under the joint influence of vitiated air, erysipelas, pyemia, and want of proper attendance. It is a notorious fact that many more patients recover after bad injuries and severe operations in the country than in the city; and, to go no further, it may confidently be asserted that an experienced operator will lose fewer cases than one who is just commencing his career.

CHAPTER XVI.

PLASTIC SURGERY.

PLASTIC SURGERY is that branch of the subject which treats of the restoration of lost parts by the transplantation of healthy integument from some neighboring region. Originally restricted to the repair of the nose, it has, during the present century, busied itself, in different ways, with the emendation of various other organs, and has thus greatly enriched the domain of general surgery; having, in fact, created a new department of operative medicine, as fertile in its resources as it has already been brilliant in its results. The perfection which plastic surgery has attained within the last twenty-five years is truly wonderful, and affords a striking evidence of the ingenuity, talent, and enterprise of the medical profession in different parts of the world. It has literally been a field of conquests, upon which have been achieved some of the proudest triumphs of the human mind in modern times. Among the many names that are honorably associated with this department of surgery, on account of their persevering efforts to advance its interests, those of Carpue, Dieffenbach, Blandin, Zeis, Jobert, Serre, Liston, and Von Ammon of Europe, and Pancoast, J. M. Warren, Mütter, Buck, Post, Hamilton, Prince, and several others of this country, hold deservedly a high rank. Some of these surgeons have composed able treatises on plastic surgery, and have thus indelibly identified themselves with its history.

Various names have been devised to designate this branch of surgery. Thus, Blandin denominates it autoplasty, while Velpeau prefers the word anaplasty, such literally signifying reconstruction. By others the term plastic, from the Greek verb to mould, model, or adjust, is used, and this is, perhaps, less objectionable than any other; at all events, it possesses the advantage of being easily understood.

It is exceedingly probable that one branch of plastic surgery has been practised in India from time immemorial. In that country the barbarous custom has existed for ages of punishing certain classes of criminals by cutting off their noses, and there can be no doubt that sympathy for these poor wretches gradually induced persons to turn their attention to the means of affording them relief. Hence arose rhinoplasty, or the operation of making new noses, pursued chiefly by a low order of native priests, whose ignorance of the healing art was too profound to justify the idea that their efforts were often crowned with success. According to Galen, the ancient Egyptians were well acquainted with rhinoplasty, but self-interest and pride prevented them from communicating a knowledge of it to other nations. Whether the operation was ever performed in Greece and Rome history does not inform us, although it can hardly be supposed that, if it had been, it would have been silent upon the subject. In Europe attention was first prominently drawn to the restoration of lost parts by Gaspar Taliacozzio, Professor of Anatomy and Surgery in the University of Bologna. In a work on the subject, remarkable for its erudition, and the simplicity of its diction, published at Venice, in 1597, he has described with great minuteness the art of repairing mutilated noses, lips, and ears, illustrated by numerous engravings. It bears the title of "De Curtorum Chirurgia per insitionem," and is curious as furnishing a record of the observation and experience of a truly great surgeon soon after the revival of learning. His practice must have been very great as a rhinoplastic surgeon, for it is distinctly stated that patients visited him from all parts of Europe. The pupils of Taliacozzio, settling in different parts of the continent, took great pains to disseminate a knowledge of the operation among the profession, although it does not seem to have been often applied in practice, doubtless from fear of failure. The operation, moreover, was doomed to encounter many obstacles from ridicule, which always exerts a powerful influence upon the weak and prejudiced in every country, and not unfrequently has the effect of throwing a new and useful invention completely into the shade.

The method of Taliacozzio consists in borrowing the required material from the arm; the operation is very tedious and complex, and has been almost entirely superseded by the Indian method, in which the flap is taken from the forehead. These two processes

will be described in their proper place. Meanwhile, it may be observed that the Oriental operation was first successfully performed in Europe in 1814, by Carpue, of London, who, in 1816, published an account of this and of another case, equally fortunate. To Dieffenbach, however, more than to any one else, is due the merit of having first generalized the operation, by pointing out the sphere of its application.

The nomenclature of these plastic operations has assumed quite an imposing character, from the numerous structures to which they are applicable. It is formed by adding the word "plasty" to the anatomical name of the part concerned, as rhinoplasty, genioplasty, and urethroplasty. Before I proceed to speak of these operations separately, it will be necessary to offer some remarks of a general nature respecting the causes which necessitate them, the preparation of the system, the proper mode of conducting them, and the character of the after-treatment.

The causes necessitating these operations are various kinds of accidents and diseases. Thus, in India, as already stated, rhinoplasty is generally required on account of wilful mutilation of the nose as a punishment for crime; in Germany, on the contrary, it is often called for on account of injury sustained by the small sword in duelling. The vicious cicatrices left by burns and scalds frequently lead to the necessity of their performance; in fact, a large field for plastic surgery has been opened in this class of lesions, in which good service was rendered by the late Dr. Mütter, since attention was first directed to it. Of the various diseases which may create a necessity for this kind of interference, carcinoma, struma, and syphilis occupy the first rank, these affections not unfrequently destroying the greater portion of the nose and lip, and thus causing the most disgusting deformity. Genioplasty is generally required on account of ulceration of the cheek from the effects of mercury; and urethroplasty, in consequence of urinary fistule, the result generally of stricture and abscess.

Whatever may be the causes leading to the necessity of these operations, none should ever be undertaken without thorough preparation of the system, extending through a number of days, if not several weeks. Upon this subject it is impossible to insist too strongly. I have seen enough of these cases to satisfy me that too little attention is paid to preliminary treatment, and that most of the failures which attend the procedure are due to the neglect of this precaution, for which there is the less excuse, seeing that there is never any need of immediate interference. There is no necessity, unless the patient is very plethoric, for the use of the lancet; light diet, rest, and an occasional purgative will generally suffice to bring down the system to a proper point of tolerance for the approaching ordeal. If the patient is from abroad, he must not be molested until he has recovered from his fatigue, and become accustomed, in some degree, to his apartment and to those who are to attend to his wants. His room should be spacious, cheerful, and well ventilated. If the weather be cold, the temperature should be regulated by the thermometer, uniformity in this respect being of paramount importance to the success of the enterprise. No operation of this kind should be undertaken in the heat of summer, or during the existence of any bodily ailment.

It is hardly necessary to state that no plastic operation should ever be attempted so long as the disease necessitating it is not completely eradicated from the part and system. It would be the height of folly, for example, to undertake the restoration of a nose lost in consequence of syphilis if there were any traces of this affection, in any portion of the body, however remote, or however distinctly connected with the disfigured organ; for there could be no possible guarantee here that the disease might not attack the new nose or the adjoining parts of the old, and so frustrate the design of the surgeon. Besides, even supposing that such an untoward occurrence did not take place, still, it would be improper to operate, because the subjects of this disease are not only very prone to erysipelas, but wounds in them generally unite with more difficulty than in healthy persons. The same remarks apply to struma, although I have great doubts whether this disease, by itself, ever destroyed any nose, ear, or lip. The mischief that is so often ascribed to it is nearly always done by syphilis, or by a combination of these affections from the transmission of the two poisons from the parent to the offspring. It is different with carcinoma. Here the plastic operation may, generally, be performed immediately after the excision of the offending disease.

The manner of executing the operation relates to the position of the patient, the surgeon, and the assistants; the administration of the anæsthetic; the mode of selecting, making, and fastening the flaps; and several other circumstances which it is not necessary to specify.

If the operation be very simple, and likely to be soon over, the patient may sit up;

otherwise he should lie down, his head and shoulders being properly supported by pillows. The surgeon and the assistants should dispose themselves in such a manner as may seem most useful for the prompt and successful execution of the operation. An anæsthetic is proper in almost every case, since the operation is frequently not only very tedious, but it is always desirable that the patient should be as passive as possible while it is in progress.

There are, as has already been stated, two points from which the integument may be transplanted for filling up the chasm in the mutilated organ; either from the immediate vicinity of the part or from a distance. Thus, in making a new nose, or mending an old one, the flap may be taken from the forehead, according to the Indian method; or, if the gap be very small, even from the cheek, at a still shorter distance from the nose. Or the surgeon, adopting the plan of Taliacozzio, now known as the Italian operation, may borrow the necessary material from the arm, although this method, owing to its tedious and complicated character, has become almost obsolete. In some cases the flap is obtained by a kind of migratory process, being successively transferred from one region to another until it reaches its final destination. Roux in this manner attempted to close an opening in the cheek, by inserting a piece of the lower lip into the upper, and, after a time, when the parts had contracted thorough adhesions and become accustomed to each other, transferring it to the place which it was intended to occupy permanently. Such a procedure would seem, at first sight, to be puerile, but upon reflection it will readily be seen that cases might arise where it would not only be justifiable but very proper.

However obtained, it is important that the integument should, if possible, be perfectly sound; free, not only from disease, but from scars. The necessity of attention to this rule is too obvious to require comment. A cicatrice, having only a low vitality, is extremely apt to slough when transplanted. A sickly graft cannot take root on a sound bough, nor will a diseased bough permit the growth of a sound graft. To unite and maintain their future relations both must be healthy. Another point of consequence is that the flap should be as destitute as possible of hair; for, although it might be divested of this after it has grown fast in its new position, it is always best not to incur any risk of unseemliness from this source.

The size of the flap must, as a general rule, be at least one-third larger than the opening which it is intended to cover, to allow for the necessary shrinkage. If the integument be very thick, the contraction will be less than under opposite circumstances, but even here it is well for the surgeon to be on his guard, lest, when the cure is completed, the result should disappoint him. The shrinkage is always gradual, and generally continues for many months after the operation, the part gaining in thickness and density what it loses in circumference.

The shape of the flap must accurately correspond with that of the gap which it is destined to close. Hence the best plan is always to define its outline before the operation by means of a pattern, placed upon the surface whence the integument is to be taken, and marked off with ink, nitrate of silver, or, what is better than either, tincture of iodine.

The composition of the flap is a matter of paramount importance. It should consist merely of skin and connective tissue, with a small quantity of adipose substance, muscular fibre, nerves and veins being carefully excluded. The presence of a thin layer of fat is always conducive to the preservation of the flap, as it tends to protect the subcutaneous vessels, and facilitate adhesion. A large pedicle must always be left, otherwise the part may die from inadequate supply of blood and nervous fluid. No large artery should be embraced in it, as this would convey more blood into it than would be required for its nutrition, or than the veins could return.

These preliminaries being disposed of, the surgeon with a sharp scalpel pares the edges of the part to be repaired, vivifying them with great accuracy, and removing all redundant and callous matter; or he may first dissect up the flap, and do the paring afterwards, as fancy or convenience may dictate. In executing this step of the operation, great care must be taken not to press or pinch, either with the finger or forceps, any portion of the flap or old skin, but to leave everything in as natural condition as possible, since nothing will so readily promote reunion. The edges may be bevelled off or cut straight, according to circumstances, as will be more particularly described hereafter. The dissection is frequently attended with smart hemorrhage, but the rule is never to apply any ligature to the flap, lest it should interfere with the adhesive process, although any vessel of the wound that may spirt should at once be secured, and the wound itself promptly closed by suture. More or less gaping will of course remain, but

it is astonishing how small a cicatrice is usually left even in the most extensive lesions of this description.

All bleeding having ceased, the flap is gently sponged, and accurately stitched to the edges of the chasm which it is designed to close. The most eligible suture will be found to be the interrupted, with an interval of two to three lines between the threads, the ends being tied with a slip-knot over a narrow roll of adhesive plaster. The advantage of this procedure is that the suture may be loosened at any time if it be found to be too tight. Much harm is often done by placing the stitches too closely, the effect being to cut off the circulation. The twisted suture is objectionable for the reason, first, that the needles are, in many places, difficult of introduction, and secondly, that they are liable to cause too great a degree of tension. The grooved suture, so happily used in plastic surgery by the late Professor Pancoast, will be described in connection with rhinoplasty, to which it is more particularly applicable.

The dressing is completed by covering the edges of the newly related parts with lint, spread with simple cerate, or wet with olive oil, in order to prevent them from becoming dry and shrivelled, an effect very liable to happen when this precaution is not duly attended to. The surface of the flap may be protected with dry lint, or, what is generally preferable, be exposed to the air. If it is very large, it will be necessary to confine it lightly in its place with adhesive plaster and a bandage, but anything like firm pressure must be carefully avoided. The wound from which the flap has been borrowed is dressed with cold water, and a similar application may be made to the amended organ if appearances indicate that there is a likelihood of overaction. The operation being completed, the part is kept at rest in a relaxed and elevated position; a light, cooling diet is enjoined; and the air of the apartment is carefully regulated by the thermometer, an equable temperature being of the greatest consequence to the welfare both of the part and system. A full anodyne is given the moment the patient is put to bed; but, if things go on well, the bowels must not be disturbed under forty-eight hours, when they may be opened by a cooling laxative.

The sutures may be removed, on an average, from the fifth to the seventh day; but so long as they are doing well they should not be disturbed, and there are few cases in which it is proper to take all away at once. Great attention to cleanliness must be observed, and the best mode of effecting this is to irrigate the parts occasionally with the syringe.

If undue swelling and discoloration arise, the patient must be promptly bled and purged, and such local means employed as are best calculated to meet the emergency of the case. Leeches may be applied to the neighborhood of the flap, but not to the flap itself, for fear of exciting erysipelas. Occasionally a considerable flow of blood may be obtained by slightly lifting the flap at one or more points, the bleeding being encouraged with a sponge and warm water.

The great danger after an operation of this kind is erysipelas, which may be so considerable as to destroy not only the flap but also the patient. Such an occurrence should be promptly met by the topical use of the dilute tincture of iodine, and by appropriate internal remedies, especially quinine and iron, aided, if there is any tendency to a typhoid state of the system, by stimulating drinks and a generous diet. Now and then a patient is lost by pyemia, but such an event is fortunately very uncommon. Gangrene of the flap, either from inadequate nutrition, overaction, or undue constriction, occasionally occurs, and mars the success of the operation.

For a time the flap remains pale and cold, but these effects soon pass off, and are succeeded by a bluish appearance and an increase of temperature. The circulation is evidently temporarily embarrassed, the arteries conveying blood faster to the part than the veins can remove it. Hence a certain degree of stagnation ensues, followed by a bluish, threatening condition of the part, which, however, soon disappears spontaneously. Natural sensation does not return for a long time; it begins first along the edges of the flap, and thence gradually extends over the rest of its surface. For the first few months the transplanted skin may appear unnaturally large and unseemly; gradually, however, it becomes smaller, and eventually it may shrink so much as to answer but imperfectly the objects of the operation.

One of the latest improvements in plastic surgery is skin-grafting, an operation introduced, as stated in a previous chapter, in 1869, by Reverdin, and consisting in the transplantation of a bit of skin, hardly the size of a mustard seed, among the torpid granulations of an old ulcer or any raw surface indisposed to heal. Union soon occurs, and in a short time the little bud becomes the centre of a new growth,

standing, island-like, in the middle of the granulations, and serving as a point of departure for the formation of new skin. What is remarkable is the well-attested fact that epithelial scales, scraped from the cutis, and applied to the granulations of an ulcer, speedily contract adhesions, and answer nearly, if indeed not quite, as well for the purpose designed as the more perfect skin.

CHAPTER XVII.

SUBCUTANEOUS SURGERY.

SUBCUTANEOUS SURGERY is one of the creations of modern times, due chiefly to the genius and intrepidity of one man, Dr. Louis Stroymeyer, of Hanover, who was the first to practice, upon a rational and philosophical plan, a subcutaneous operation, the undertaking consisting in the division of the tendo Achillis for the cure of clubfoot. The operation was performed in February, 1831, and eventuated in the complete restoration of the use of the limb. Prior to that period several attempts had been made, by different surgeons, as Lorenz, Thilenius, Michaelis, Sartorius, and Delpech, to relieve this complaint, but they had all signally failed, simply because they had not been based upon correct scientific principles.

Since the discovery of Stromeyer, the domain of subcutaneous surgery has been greatly enlarged, by the application of its principles to other parts of the body, for the relief of which it has already performed the most valuable services. Dieffenbach, in 1839, gave it a new impulse by devising the operation for strabismus, which, although not practised by him subcutaneously, did much to inspire new confidence in the procedure, and to awaken a new interest in its application. Soon afterwards, however, the section of the muscles of the eye was performed without external wound, by Guérin, but the operation, if not obsolete, has never met with much favor by the profession. The French surgeon has extended the subcutaneous practice to the treatment of lateral curvature of the spine, by the division of the muscles of the back; and, at a more recent period still, it has been applied to the relief of numerous other affections, which would hardly admit of cure in any other manner. Among the more important procedures that have grown out of this branch of surgery are the removal of cartilaginous bodies from the joints, the radical cure of hernia, the reduction of chronic dislocations, the evacuation of abscesses, the cure of ankylosis, and the obliteration of serous cavities. Too short a time has elapsed since the discovery of subcutaneous surgery to enable us to form a just estimate of its limits, or the extent to which it may with propriety be carried into practice; but it is not difficult to perceive that in a field affording such unbounded opportunities for the exhibition of display and selfishness, much abuse must creep in, which time alone will be able to rectify.

The practice of subcutaneous surgery is founded upon the great law that all wounds and injuries occurring without an opening in the integument unite with very little, or, according to some, with no inflammation, and with no suppuration, differing thus essentially from similar lesions accompanied with a solution of continuity of the skin, which are always followed by considerable inflammation, and also very frequently, if not generally, by a discharge of pus. This law, which is now universally recognized by surgeons, was clearly enunciated by John Hunter, in his writings, near the close of the last century, but did not attract the serious attention of his countrymen until within a very recent period; not, indeed, until the facts of the subcutaneous section had been placed upon a firm and immutable basis by the practitioners of the continent of Europe. The idea of the illustrious Englishman lay in his writings, like a pebble upon the sea-shore, often seen but never observed, until accident directed attention to it years after the establishment, by others, of the great principles which he had so clearly enunciated. One reason, perhaps the chief one, of this was that he himself had never performed a subcutaneous operation: if he had, there is certainly no evidence of the fact in any of his writings. The only passage in his works which has any relevancy to the present subject is the following:—" The injuries done to sound parts, I shall divide into two sorts, according to the effects of the accident. The first kind consists of those in which the injured parts do not communicate externally, as concussions of the whole body or of particular parts, strains,

bruises, and simple fractures, either of bone or tendon, which form a large division. The second consists of those which have an external communication, comprehending wounds of all kinds, and compound fractures. Bruises which have destroyed the life of the part may be considered as a third division, partaking, at the beginning, of the nature of the first, but finally terminating like the second. The injuries of the first division, in which the parts do not communicate externally, seldom inflame, while those of the second commonly both inflame and suppurate." It is evident, from the tenor of this passage, that Hunter had carefully studied the influence of the air upon the healing of wounds, but it is not very clear, from aught that appears in it, that he had any conception whatever of the nature of subcutaneous surgery, properly so called.

Several of what are now dignified as subcutaneous operations have been performed for a long time. The mode of evacuating chronic abscesses by a valvular incision, first practised by John Abernethy, early in the present century, legitimately belongs to this division of surgery, its object, as clearly enunciated by the originator, being the exclusion of the air, on the ground that the contact of this fluid with the pus in the interior of the sac is the cause of the excessive local and constitutional disturbances which so often follow the old mode of opening these collections. Of the value of this procedure there can be no doubt, although the class of cases which it is intended to relieve is, from their very nature, unfortunately too often fatal. The operation of dividing the stricture in strangulated hernia, external to the sac, originated with J. L. Petit a century and a half ago, but has only of late years received the attention it merits. Some of the English practitioners, commencing with Ashton Key, have recently bestowed much attention upon the subject, and have adduced a body of testimony in its favor highly flattering to this mode of treatment. The object of the operation, the advantages and disadvantages of which will be considered in their appropriate place, is, by relieving the bowel subcutaneously, to guard against the occurrence of the severe inflammation which so frequently attends the ordinary procedure, even in the hands of the best practitioners. The injection of hydrocele with irritating fluids, as suggested by Sir James Earle, early in the present century, is another instance of a subcutaneous operation, which has long been familiar to the profession, and been practised by every enlightened surgeon in Europe and America. Some recent writers have gone so far as to class the use of the seton in the treatment of ununited fracture among the expedients of subcutaneous surgery: such an application is certainly carrying this department altogether beyond its legitimate limits, and is, therefore, calculated to do the subject much harm by giving to it a wrong direction. The wound made by a seton is, to all intents and purposes, an open wound, followed not only by high inflammation, but by profuse suppuration; occurrences which it is the peculiar province of subcutaneous surgery to guard against. A better example of a subcutaneous operation, performed for the relief of ununited fractures, is the division by means of a long, slender knife, of the soft tissues which form around the ends of the broken bone, the raw surfaces being afterwards approximated and maintained by appropriate apparatus.

On the whole, regarding subcutaneous surgery in its legitimate application, it appears to me that the cases to which it is adapted are susceptible of being arranged under the following heads: 1. Cases involving the division of tendons, muscles, bones, and aponeuroses for the relief of various distortions, as clubfoot, clubhand, spinal curvature, knockknee, and strabismus; the reduction of dislocations, especially those of the foot; and the cure of ankylosis of the joints, depending upon contraction of the soft parts. 2. Operations for the radical cure of hernia, whether by puncture or injection: and division of the stricture in strangulated hernia external to the sac. 3. The evacuation of chronic abscesses and of purulent, serous, and sanguineous collections of the chest and other cavities, by a valve-like opening of the skin. 4. The withdrawl of cartilaginous concretions from the joints, as originally suggested by Goyrand and Syme. 5. Operations for obliterating serous cavities, when, in consequence of inflammation, they become occupied by serous fluid; as the vaginal tunic of the testicle, certain synovial burses, especially those about the hand and wrist, and various adventitious cysts, particularly those which are so liable to form in the neck in connection with the thyroid gland. 6. The comminution, by the knife, of diseased lymphatic glands, the incision of inflamed periosteum, and the division of morbid adhesions, as those existing in chronic luxations, in depressions of the nose, and similar affections. 7. Forced extension of ankylosed joints, rendered so by the formation of fibro-ligamentous bands. 8. The subcutaneous obliteration of vascular tumors, by ligature or injection. 9. The operation for the radical cure of varicocele. 10. The relief of deformities of the hip-joint by the division of the thigh bone, as originally practised by Barton, and more recently by Sayre, Adams, Volkmann, and other surgeons.

The mode of operating for subcutaneous purposes must vary of course according to the particular indication which it is designed to fulfil. Whatever, however, the object may be, the rule is to make as small an external wound as possible, consisting, in fact, rather of a puncture than an incision, for it is ever to be borne in mind that one of the cardinal aims of every procedure of the kind is the exclusion of the air. The knife with which the operation is performed must, therefore, always be very narrow, sharp-pointed, and rather short, a length of edge from half an inch to an inch being a good average. The annexed sketch, fig. 206, represents the knife which I have long been in the habit of using in all my subcutaneous operations. Such an instrument is generally much more manageable than a longer one, while one of greater width would make too large an opening. If the object be to evacuate an abscess, a medium-sized trocar

Fig. 206.

Tenotome.

may be used, the skin having previously been divided with a bistoury. The instrument is then passed for a variable distance—usually from an inch to an inch and a half—through the subcutaneous connective tissue, when its point is plunged into the pyogenic pouch, its entrance being denoted by the want of resistance and the escape, perhaps, of a few drops of thin pus. In extracting cartilaginous concretions from the joints, a delicate knife is carried along under the integument through the capsular ligament and synovial membrane, which are then divided to a sufficient extent to admit of the displacement of the morbid growth, previously fixed by the thumb and fingers, into the connective tissue external to the articulation, from which, after the wound is healed, it is removed by a second operation. The operation for the radical cure of hernia, requiring instruments of particular construction and use, will be described in its proper place, and so in regard to several other procedures which cannot be here noticed.

All operations of this kind should be performed with great gentleness and care; for whenever this is done, there will be no risk either of severe inflammation, or of the division of any important vessels, nerves, or other structures not concerned in the particular affection for the relief of which the procedure is undertaken. I do not agree with those who maintain that tendons and other textures may be cut without the operation being followed by inflammation; on the contrary, I am convinced that a certain degree of incited action is present in every instance, and, if this view be correct, it proves how important it is that it should be kept within proper limits. This subject, however, will again be adverted to in speaking of tenotomy. In general, the little puncture made in the operation unites in a few hours, while the gap which intervenes between the retracted ends of the divided structure is gradually filled up by plastic matter, which is eventually converted into analogous tissue.

Most subcutaneous operations are nearly bloodless, a circumstance which constitutes one of their leading peculiarities. While open wounds always bleed, to a greater or less extent, those made beneath the skin by a narrow, sharp-pointed knife, used with proper care, are almost free from hemorrhage. In dividing the tendo Achillis for clubfoot, frequently not more than a few drops of blood are lost. As to shock, or serious depression of the nervous system, consequent upon such an operation, such an occurrence is never witnessed. The procedure, however, is not always free from pain, especially during the efforts which are sometimes required to straighten the affected part after the division of the faulty structures; and hence it is often useful to administer an anæsthetic, the more so, because this not only prevents suffering, but, by rendering the patient passive, gives the surgeon more complete control over his own movements.

Active preparatory treatment is rarely required in these operations. I have frequently performed the most extensive tenotomy at the College Clinic, as well as in private practice, upon children whom I had seen for the first time only an hour before, and yet in no instance, so far as I have been able to learn, have any bad effects followed. The operations, however, for the radical cure of hernia, for breaking up adhesions in ankylosis, for the removal of cartilaginous bodies from the joints, and for the relief of some other affections, always demand more or less attention of this kind.

The after-treatment, for the first few days, is generally very simple. As soon as the operation is over, the little wound is covered with adhesive strips, to exclude the air, and the part, surrounded by a bandage, is maintained in a perfectly easy, quiet position. If active inflammation arise, which, however, is seldom the case, the usual antiphlogistics

must be employed. After nearly all such operations suppuration must be prevented at all hazard.

When the operation is practised for the relief of some deformity, as clubfoot or spinal curvature, the cutting constitutes only a trivial part of the procedure. The great care and trouble of the case come afterwards, in the fitting and wearing of the necessary apparatus. It is usually recommended that no apparatus should be used until after the lapse of several days, or until the primary effects of the operation have passed off. I have, however, in many cases, so far deviated from this rule as to confine the affected limb at once, and usually without any disadvantage. Indeed, I am strongly inclined to believe that this ought to be the rule, and delay the exception. As this subject, however, will be considered in connection with the various operations to which it relates, any further remarks upon it here would be out of place.

CHAPTER XVIII.

AMPUTATIONS IN GENERAL.

SECT. I.—INTRODUCTORY CONSIDERATIONS.

THE word amputation was formerly, and is occasionally even yet, employed to signify the removal of various kinds of tumors; thus, many of the older writers speak of amputation of the breast, amputation of the jaw, and amputation of the scrotum. At the present day, however, the term excision is generally used as more appropriate in connection with these procedures, while that of amputation is applied exclusively to operations for the removal of the limbs, whether in their continuity or at their articulations.

I cannot agree with those who have denounced amputations as a disgrace to surgery; it is only when they are performed unnecessarily that they ought to be stigmatized by the profession and the public as an evil. Every pursuit is liable to abuse, to sins of omission and commission, and it would be strange if limbs were not occasionally cut off that might, under judicious management, have been saved. To denounce amputations, and to declare that they afford evidence only of the impotency and imperfection of our art, is to take a very narrow and erroneous view of the subject. It is not intended, so far as our own feeble powers of reflection enable us to comprehend the matter, that man should be able to cure every disease to which "flesh is heir." There are many maladies, as well as accidents, which are of necessity mortal; lesions which no human agency can repair or remedy. Who can save a limb that has been mangled and cut to pieces by the passage of a railway car, by the explosion of a steamboat boiler, by the fierce contact of a cannon ball, or by a fall from the top of a house down upon a heap of stones? Where is the surgeon that can prevent mortification from a burn that has charred the flesh, from a cold that has completely frozen the toes and feet, or from a malignant pustule that has inoculated all the tissues of an extremity? Is surgery to be held responsible because it cannot cure sarcoma of the bones, scrofula of the joints, and aneurism of the thigh and leg? So far from imputing blame to it, in these and similar cases, we should be grateful for the assistance which it is capable of affording us as a means of relieving suffering and prolonging life. It is under such circumstances, in particular, that we can best appreciate its great and inestimable value. If it were not for the merciful interposition here of the knife, such cases would inevitably be doomed to a rapid and miserable death. Mortification would speedily do its work, the sarcomatous tumor would steadily spread and finally ulcerate, forming a frightful, disgusting, and painful mass of disease, and the scrofulous joint would soon wear out the system by hectic irritation. It is a sad thing to lose a limb, but it is also a sad thing to die; and what rational being, if he could have his choice, would not rather part with an extremity than with his life? No humane, enlightened, and conscientious surgeon will ever resort to amputation without being satisfied of its entire and perfect necessity; if he is young and inexperienced, he will be sure to avail himself of the best counsel within his reach, while, if he is thrown upon his own resources, he will not fail to give the case all the consideration and reflection that his own knowledge, wisdom, and judgment may enable him to bring to his aid for

the relief of the poor sufferer whom he is obliged to mutilate in order that he may rescue his life from the dangers which threaten him.   I know of no operation which I approach with so much reluctance as the amputation of a limb, or one which gives me more real pain.   To cut off an arm at the shoulder on account of an incipient sarcomatous affection of the head of the humerus, when the elbow, forearm, hand, and fingers are all perfectly natural and glowing with health, unconscious, so to speak, of the fate which awaits them, is enough to sicken the stoutest heart, and to discourage the boldest operator. If there is a more disagreeable task than this, I am ignorant of it ; and yet I would not shrink from its performance even when there is but a faint prospect of prolonging life, if only for a few months.   But the case is different, widely different, when the surgeon is called upon to amputate a limb crushed and lacerated by machinery ; here there is no choice, no question concerning a cure by mere therapeutic measures ; the knife is the only remedy, and the sooner it does its work the greater, as a general rule, will be the patient's chance of recovery.   The body, it is true, is mutilated, perhaps sadly disfigured, but life is safe, and surgery, science, and humanity have achieved a real triumph.   So long as there are accidents and diseases incurable by medical treatment, so long will there be a necessity for amputation, and happy is he who shall know when and how to perform it to the best advantage for his patient and the greatest credit to the art and science of surgery.

SECT. II.—CIRCUMSTANCES DEMANDING AMPUTATION.

The circumstances for which amputation may be required are not only numerous, but extremely diversified in their character, and, therefore, deserving of the most careful consideration.   They may be comprised under the following heads :—1. External injury, as wounds, fractures, and dislocations.   2. Mortification, however induced.   3. Morbid growths.   4. Aneurisms.   5. Diseases of the bones and joints.   6. Intractable ulcers. 7. Malformations and deformities.   8. Tetanus.   The topics here enumerated comprise almost every kind of morbid action that can arise in the animal economy, and it will be perceived that they afford a wide and complicated field for the exercise of the talents and judgment of the surgeon.   Space will not permit me to enter as fully into their details as might, perhaps, be desired ; but I shall endeavor to advert briefly to the more important facts included under each head, having already called attention to some of them in the chapters on gangrene and wounds.

1. *Injuries.*   There are no lesions for which amputations are so frequently required as for wounds, fractures and dislocations.   Although they differ widely from each other in regard to the nature of the structures involved, these injuries may all be very properly classed under the same head, the more especially as they often coexist, thus rendering it difficult to determine which of them is the most serious.

Of wounds, properly so called, the only ones which require to be considered in connection with the present subject are the lacerated, contused, gunshot, and railway.   Wounds inflicted by rabid animals occasionally, it is true, demand amputation, particularly when they extend deeply among the bones, as in the hands and feet ; but even here complete riddance may generally be easily effected by a careful excision of the bitten parts, and the cauterization of the raw surface after the cessation of hemorrhage.   I should certainly hesitate to cut off an arm or a leg in such an event ; with the knife and saw I should expect to accomplish all that was necessary, in any case, for the safety of the patient.

Lacerated wounds, as well as contused and gunshot wounds, of a most frightful, and, at first sight, apparently of the most desperate character, are sometimes recovered from in an extraordinarily short time, and with hardly any untoward symptoms.   On the other hand, experience shows that the most insignificant injuries of this kind occasionally prove fatal in a manner and under circumstances which render it extremely difficult to account for the result.   It would be fortunate, both for our patients and for the interests of science, if we could always form, if not a positive, at least an approximate, estimate of the danger involved in each particular case of these wounds, for then it would be comparatively easy to adopt a suitable plan of treatment ; but, as it is, much must be left, in every instance, to the experience and judgment of the practitioner.   In general, however, it may be observed that all such wounds are fraught with danger, both to limb and life, when they are attended with extensive laceration of the soft parts, when the muscles have been horribly bruised and pulpified, important nerves cut across, the principal arteries, or arteries and veins, torn open, large joints penetrated, and the bones broken in pieces.   Under such circumstances there is not even a "forlorn hope," no matter what may have been the

previous health and habits of the sufferer; the knife is required, and the sooner it is employed the better. Such cases are absolutely desperate, and no one who has any knowledge of consequences can hesitate as to the course to be pursued. Upon this point there is no discrepancy of opinion whatever among surgeons. But the injury may be of a less severe character, involving, it may be, merely a considerable contusion of the soft structures with a compound fracture; or several muscles may be badly lacerated and the principal artery of a limb cut across; or a large nerve, the main trunk, perhaps, be divided, or the interior of a large joint exposed. The case now assumes a more trying aspect; the responsibility falls upon the surgeon with tenfold force; for the question naturally and at once arises, What shall be done? Shall such a limb be immediately amputated, or shall an attempt be made to preserve it? This is a question which will probably be asked by the patient himself, or by his friends for him, and which it is often extremely embarrassing and difficult to answer; in fact, it can only be answered upon general principles in one sense, and upon special principles in another. Looking at such injuries in a general manner, we might be inclined to give a favorable prognosis, because it is undoubtedly true that recovery from such lesions is by no means uncommon; but when we come to examine into the particulars of the case, we might not regard it in so auspicious a light. Thus, for example, the patient's antecedents may all have been bad, perhaps of the worst possible description; intemperance and dissipation of various kinds may have undermined his constitution, and thus rendered it unable to bear up under an injury which he would formerly have supported without difficulty; or, instead of this, there may be serious structural disease of some vital organ, as the heart, stomach, or lungs, disqualifying him for enduring the accidental and now heavy burden. All these circumstances must have their weight with the practitioner when he sits in judgment respecting the propriety or impropriety of an amputation. Conservative surgery may and does do much, but it cannot do everything; it has its limits, beyond which it cannot safely go, and there are many points which require to be considered in order that it may do itself justice. A very severe injury, occurring in a stout youth, of healthy constitution and temperate habits, is often promptly recovered from, while less than one-third of its amount, in a sickly, anemic, or dissipated person, will frequently destroy life in a few days; or, at all events, so far endanger it as to cause great anxiety for the result.

Gunshot, railway, and steamboat accidents, and injuries occasioned by the caving in of stone quarries, are extremely liable, if an attempt be made to save the limb, to be followed by the worst results; and, what is particularly embarrassing, in these cases, is the difficulty which the practitioner often has to encounter in ascertaining the precise amount of the lesion. The limb, perhaps, is entirely free from contusion and wound; or, if there be any injury of this kind, it may be so slight as to be regarded as of no consequence. The mischief is deep-seated, and, upon careful examination, it will, probably, be found to involve nearly every important structure, muscle, tendon, aponuerosis, vessel, nerve, bone, and joint. Such cases obviously require the closest scrutiny with a view to the speedy detection of their true nature and their proper mode of management. Generally the limb is so hopelessly injured as to require removal.

Compound fractures and dislocations, and gunshot wounds of the joints, often require amputation, and yet it is remarkable how the parts and system sometimes bear up under such injuries, especially in young and healthy subjects. Under the improved methods of management of modern surgery recoveries occasionally occur, which, in former times, when their treatment was less perfectly understood than it is now, would have astonished the practitioner. In this country the treatment of compound fractures and dislocations by occlusion, thereby converting these lesions into simple accidents, and of the former by extending and counterextending bands of adhesive plaster, has greatly contributed to this result. The danger of these injuries is much greater, other things being equal, when they occur in the inferior extremity than when they are situated in the arm and forearm, and in all cases the risk is much increased when they are accompanied by an open state of an important articulation, as that of the hip, knee, or ankle. Compound fractures in the continuity of a limb, unless complicated with serious lesion of the soft structures, do not generally require amputation; if judiciously managed, they will usually get well without much trouble. Gunshot wounds, occurring in civil practice, are commonly less dangerous than injuries of this kind happening on the field of battle or on shipboard. I have seen enough of the former of these accidents to satisfy me that the patient will often recover with a very good limb, even when there has been extensive loss of substance and great comminution of the bones. In military practice, on the contrary, there will often be much difficulty in preserving the parts, simply because it is frequently impossible to

treat the case properly on account of the want of suitable accommodations and a salubrious atmosphere.   It is for these reasons that amputation is so often resorted to, during and after engagements, in cases which, if they took place under ordinary circumstances, could be successfully managed by milder means.

When amputation is determined upon, in these and similar accidents, the next question is, when should it be performed?   Should it be done immediately, or should the surgeon wait until the system has recovered from the shock of the injury?   To use the knife while the patient is in an exhausted, pallid, and, perhaps, almost pulseless condition, would only serve the more certainly and effectually to seal his fate ; the additional shock to the constitution from the loss of blood and nervous fluid could hardly fail to prove most disastrous.   Hence the rule is to postpone a resort to the knife until there is satisfactory evidence of reaction ; until, in a word, warmth and color return to the surface, the pulse beats vigorously at the wrist, and the sufferer regains, in some degree, his consciousness and courage.   Now the use of an anæsthetic is well borne, and the limb is removed with comparative impunity.   On the other hand, care is taken not to wait until the part and system are assailed by inflammation, which, under such circumstances, often extends with frightful rapidity, placing the case, perhaps, literally beyond the resources of surgery in the course of a few hours.   There is, therefore, a time when interference must be avoided, not less than when it must be courted.   The limits of these two periods are not always well defined, and must, therefore, be left, in each individual case, to the judgment of the attendant.

An amputation, performed immediately after the occurrence of reaction, is usually designated by the prefix "primary," while the term "secondary" is used to denote the operation when it is executed after the limb has passed through the different stages of inflammation, an attempt having been made, perhaps well grounded, so far as the interpretation of the symptoms is concerned, to save the parts.   Such a contingency must necessarily happen rather frequently, especially in civil practice ; indeed, it is often altogether unavoidable on account of the obstacles interposed by the patient and his friends, independently of the wavering and indecision of the professional attendant.   But, although often unavoidable, such an occurrence is always much to be regretted ; for if the chances of saving limb and life were bad in the first instance, they are now generally much worse ; the system has been impaired by fever and perhaps hectic irritation, the secretions are seriously deranged, the patient has little appetite and sleep, the blood is thin and watery, and the whole body is much emaciated.   Life may possibly still be preserved, but the probability is that the operation will be attended with much risk, and that ultimate recovery is far off.   Moreover, a much larger amount of limb may now have to be sacrificed ; originally a foot might have sufficed, whereas now, in consequence of the ravages of the inflammation, the whole leg may require removal.   There is, then, obviously, an advantage in a primary over a secondary amputation, provided it is performed at the proper time, that is, after the establishment of reaction and before the occurrence of inflammation ; and this circumstance is often eagerly embraced by the military surgeon, whose will is always law with his patients.

In addition to these divisions, some writers speak of what they term an "intermediary" amputation, performed immediately, or soon, after the supervention of inflammation, and, consequently, before the establishment of suppuration.   This distinction was first made by Bucher, in the last century, in a memoir addressed to the French Academy, and was subsequently adopted by Guthrie, Alcock, and other military surgeons, in the early part of the present.   Such an amputation is unquestionably the very worst that can be selected, inasmuch as it is performed at a period when the part and system, assailed by inflammation and fever, are ill able to bear up under its effects.   Hence the mortality must necessarily be much greater than after either of the other procedures ; and yet it is easy to perceive that cases might arise, both in private, hospital, and military practice, where it would be perfectly unavoidable.   Accidents, as gunshot, railway, and other injuries, of the very worst character, must often occur under circumstances in which the patient is either neglected, or where it is impossible to remove the mutilated parts before the occurrence of inflammation and symptomatic disturbance.   The moment the surgeon sees the case it is obvious at a glance that amputation is necessary ; there is no other chance for the patient's life ; nor is any time to be lost.   Mortification is either impending or has already taken place, and in a few hours the case may be wholly beyond the reach of the knife.   Here there is no choice.   Operative interference is compulsory and imperative. In estimating the mortality of primary and secondary amputations it is very important to exclude the intermediary, otherwise the calculations must lead to error.

2. *Mortification.*—Mortification, in whatever manner induced, necessarily imperils limb and life, and, therefore, often becomes a subject for amputation. Hence the question arises, under what circumstances is a resort to the operation advisable and proper? This question can only be answered satisfactorily by a consideration of the nature of the mortification. In the chapter on mortification will be found an account of the several varieties of this affection, the causes under the influence of which they take place, their symptoms, and the means required for their relief. By a reference to that portion of the work, it will be seen that, as it respects the operation under notice, the great rule, recognized by nearly all practitioners at the present day, in acute gangrene, is, to wait for the formation of a line of demarcation between the dead and living parts, on the ground that it is not generally safe to interfere sooner, lest the disease should reappear upon the stump, and thus destroy the patient, or necessitate a repetition of the amputation. Of the propriety of this rule there can be no question, for there is no surgeon of experience who has not witnessed its beneficial effects in his own practice, as well as in that of his friends, and yet it is equally true that it may occasionally be violated with great advantage. But I would apply to these cases the term "exceptional," comprising under this head those attacks of mortification which are so liable to supervene upon inflammation from external injury, as wounds, fractures, and dislocations, which often spread with immense rapidity, hopelessly overwhelming, if they are not promptly arrested, both the part and system in a few hours. It will not do for the surgeon, in such an emergency, to fold his arms and become an idle spectator; he must have his eyes and wits about him, or his patient will be irretrievably lost; whatever is done must be done quickly. The wished-for line of demarcation will be looked for in vain; the gangrene will rapidly extend to the trunk, and death must soon close the scene. But in spontaneous mortification, or in mortification from erysipelas, carbuncle, and analogous affections, the judicious surgeon waits for the arrest of the morbid action, his chief care being to bring about this event as speedily as possible by appropriate local and constitutional measures. His rule of action is the same in hospital gangrene; in both cases means are employed for supporting the system, or, what is equivalent to the same thing, for improving the condition of the fluids and solids, and the knife is used only when the line of circumvallation is fully established, not a minute before.

In senile, chronic, or dry gangrene, the result usually of calcification of the arteries and of their occlusion by fibrinous concretions, thus depriving the tissues of their due supply of blood, the rule has heretofore been to wait for the cessation of the mortification, experience having shown that, when this precaution is neglected, the disease will be certain to reappear in the stump. It is in view of this relapsing tendency in mortification that some surgeons, of great eminence and experience, have given it as their judgment that the case should always be left entirely to nature's efforts; in other words, that we should wait for spontaneous amputation, shaping the stump after the sloughs have been nearly completely detached, when, it is alleged, the part and system will be better prepared to withstand the shock of the knife. The propriety of such advice is sufficiently obvious when it is considered that this disease occurs nearly always in very old and infirm subjects, and that it is essentially dependent upon obstruction of the arteries leading to the affected structures. Such individuals, as I know from personal observation, are usually very feeble, and, consequently, ill able to resist the effects of shock or loss of blood. They often rapidly sink after the operation, even when there has been a distinct line of demarcation; or, if they survive its immediate effects, the disease speedily reappears upon the stump, and soon destroys life secondarily. When we reflect how common these events are, would it not be wise, in these cases, to amputate early at a great distance from the disease, before the vital powers have been seriously assailed by the morbid action; to remove, for instance, the limb at the knee, for senile or chronic gangrene of the toes and feet? The only objection to such a procedure, it seems to me, would be where the occlusion of the main artery of the limb reaches above this point. When no such disease exists, and the general health has not materially suffered, I should not hesitate to resort to the expedient, under the conviction that, however severe, it was perfectly justifiable in a class of cases so unpromising as this confessedly is.

3. *Morbid Growths.*—Amputation is sometimes required on account of morbid growths or tumors, both benign and malignant. The removal of the forearm is perfectly proper for the cure of sarcoma of the hand, and of the arm at the shoulder for a similar affection of the humerus. A similar rule is applicable to the inferior extremity. Half-way measures here, as elsewhere, are worse than useless. To amputate in the continuity of

the thigh when the lower part of the limb is affected with a malignant growth would be a blunder and a crime. No operation is of course admissible if there be marked constitutional involvement, enlargement of the neighboring lymphatic glands, or decided tendency to ulceration; the propitious period has gone by, and interference would only hasten the fatal event. It is not so, however, so long as the health remains good, and there is no evidence of general or local contamination; under such circumstances there is a strong probability that removal of the limb, although it may not prevent a recurrence of the disease, may yet considerably prolong the patient's life.

A tumor, wholly divested of malignancy, may, in consequence of acting obstructingly, cause so much functional and other disturbance as to demand removal of the limb upon which it is situated. The procedure will be particularly called for when the morbid growth is intimately connected with a bone, or deeply and inseparably involved in the soft parts, or prolonged into an important joint, compelling free exposure of its surfaces during the operation. A valuable rule in tumors is to excise the benign, and to get rid of the malignant by amputation.

4. *Aneurism.*—A neglected aneurism, seated in an extremity, and unamenable to ordinary treatment, occasionally calls for the removal of a limb; in former times such operations were sufficiently frequent when the disease occupied the popliteal region, though at present they are seldom, if ever, required, except when mortification sets in after ligation of the femoral artery, or from the injurious compression exerted by the tumor upon the leg.

5. *Affections of Bones and Joints.*—Various affections of the bones and joints, as caries, necrosis, morbid growths, tuberculosis, and ankylosis, may impose the necessity of amputation; and there is, according to my experience, no class of diseases in which the operation has been more frequently abused or misapplied. There can be no question that many a limb, merely temporarily crippled by remediable disease, has been ruthlessly sacrificed to ignorance and a desire for eclat: carious joints, now that excision has been revived, can seldom demand so harsh a procedure, and as to necrosis, pure and uncomplicated, it is difficult to conceive of a case justifying the use of the knife. It is only, or mainly, in white swelling, or scrofulous disease of the knee, ankle, and elbow, attended with hectic irritation, excessive pain, and exhausting diarrhœa, that the removal of a limb can be proper, and even then it should not be thought of if it be possible to exsect the affected structures without imperilling life by shock and loss of blood. In whatever manner the offending parts are disposed of, it is surprising to witness the great improvement which usually follows the operation; the profuse sweats and alvine discharges rapidly disappear, the appetite improves, the sleep becomes refreshing, and the patient soon regains his flesh and strength. Unfortunately, the operation is generally put off to an unreasonable period, so that, when it is at length performed, the sufferer too frequently sinks under its effects.

Of malignant growths of the bones almost the only primary one demanding amputation of the limbs is sarcoma. When epithelioma of the skin extends to the osseous system, as sometimes happens, the same treatment must be applied to it as to sarcoma; that is, early and thorough removal by the sacrifice of the suffering extremity. Temporary relief only, as a rule, is aimed at; sooner or later the disease recurs, either at the cicatrice, or in some neighboring organ, and carries off the patient.

Fibrous, cartilaginous, and osseous growths involving the bones sometimes constitute a legitimate ground for amputation. An exostosis, of enormous size, and grotesque form, may render an extremity not only perfectly useless, but a source of the greatest inconvenience and even suffering. Pulsating tumors of the osseous tissue, met with chiefly in the head of the tibia, nearly always demand the same remedy.

Finally, amputation may be required on account of ankylosis of a joint, interfering with the comfort and usefulness of an extremity. Thus, in ankylosis of the knee, the leg may stand off at a right angle with the thigh, so as to interfere materially with the occupation of the individual, and induce a wish for an artificial limb, which, if well constructed, is generally worn with great satisfaction. Stiff and crooked fingers and toes are often the subjects of amputation.

6. *Ulcers.*—Amputation is sometimes performed on account of old and inveterate ulcers of the extremities; the operation, however, is less frequently resorted to now than formerly, and might, with proper management, be almost entirely dispensed with. Unless the sore is of a carcinomatous character, or caused by burns, scalds, or frost-bites, or complicated with serious lesion of the bones, excessive enlargement of the veins, or great

hypertrophy of the integument, there are few cases, it seems to me, that will not gradually yield to judicious treatment. Of the numerous ulcers of the extremities that have fallen under my observation, embracing, of course, many of the worst description, I have a distinct recollection only of three that required this harsh measure. Whether other practitioners have been equally fortunate I am not able to state ; but, judging from the reports of cases in our periodicals, it is highly probable that the operation is still not unfrequently performed on this account.

7. *Malformations.*—There are certain malformations and deformities for the relief of which amputation may be demanded. An irremediable clubfoot, especially if complicated with a painful bunion, an intractable ulcer, or excessive atrophy of the leg, would form a proper subject for such an operation ; for there are few men who would not rather run the risk attending its performance than to be incessantly fretted and worried by such a disagreeable and useless companion. Supernumerary thumbs and fingers are disposed of in a similar manner ; the operation is usually done within a few months after birth, and I have never known it to be followed by any bad consequences. Amputation is occasionally necessary on account of deformity caused by burns and scalds, or badly treated fractures and luxations.

8. *Tetanus.*—The propriety of amputating in tetanus has been so long doubted by many of the highest authorities in surgery that the question hardly merits serious consideration in a work of this kind. I have certainly not seen anything in my own practice tending to contradict an opinion now almost universally entertained by the profession in this and other countries. If such a measure is ever justifiable, it must be at the very commencement of the disease, before the supervention of the characteristic symptoms. I have seen a very considerable number of instances of acute traumatic tetanus, and, with a few solitary exceptions, they have all proved fatal. One of the cases was that of a stout, well-fed countryman, fifty years of age, the fore and middle fingers of whose right hand had been badly crushed by the passage of the wheel of a wagon ; symptoms of tetanus came on upwards of a month after the accident, and, although the disease had existed for five days when I amputated at the metacarpo-phalangeal articulation, yet complete recovery followed, not, however, without a slight continuance of the spasms for a short time after. In another case the little finger of the left hand had been crushed a fortnight previously, and I amputated it the morning after my first visit. Although the symptoms had all day been very severe, a gradual improvement soon became apparent, and the patient, a young man, twenty-four years of age, made an excellent recovery. The principal remedies were saturnine and anodyne lotions, quinine, morphia, and milk punch in liberal quantities. I presume a practitioner would hesitate to cut off a large limb after the development of tetanus under any circumstances ; for, whatever notions may be entertained respecting the pathology of this affection, there can be no doubt that, once fully established, it must be looked upon as a constitutional disorder in the widest sense of that term.

SECT. III.—METHODS OF AMPUTATION.

Two principal methods are in vogue for performing amputation of the limbs, whether in their continuity or at the joints. These are the circular and the flap, both of which, but especially the former, are of ancient date, and therefore well grounded in the esteem of the profession. To these was added, early in the present century, the oval operation, which, although excellent in its way, has hitherto received but little attention ; certainly less than it deserves. In 1855, an operation, termed the rectangular, was also proposed. At present, flaps constructed entirely of integument are much in vogue. It is not my object to enter into the history of these different methods, for to do so would carry me back into the regions of doubt and speculation ; but it will be expected that I should offer some remarks concerning their respective advantages and disadvantages, and this I shall endeavor to do in as concise and impartial a manner as may be consistent with the great interest and importance of the subject.

1. *Circular Method.*—The circular operation, the most ancient of all, was originally performed in the most simple manner, the integument, muscles, and bones being all divided upon the same level. The consequence of this procedure was that the bones, inadequately covered by the soft parts, or, rather, not covered at all, invariably perished to the distance of several inches, thus sadly protracting the cure, besides subjecting the patient to much suffering and not a little risk in the interval. As surgeons became more

enlightened, they endeavored to provide against this contingency by forcibly pulling back the muscles, by means of a peculiar contrivance called a retractor, before using the saw, which was then applied close to the surface of the tissues. At a later period still, and as a decided improvement upon the preceding methods, arose the plan of double incision, devised by Cheselden, better known for his success as a lithotomist than for his exploits as a general operator. It consisted, as, indeed, the name sufficiently indicates, of two stages, in the first of which the integument was cut and drawn back, while in the second the muscles were divided higher up, the object being to afford more thorough protection to the bone. The operation of the English surgeon has undergone various modifications, some of which, having only served to render it more complex, have been justly discarded from practice. To this category belong the division of the muscles by two circular incisions, one higher up than the other, and the plan of scooping out the parts as the knife was being swept obliquely around them by cutting from below upwards and from without inwards towards the bone, which thus formed the apex of the hollow cone.

The circular operation, as now generally practised, consists, first, in dividing the common integument, dissecting it from the parts beneath, to a variable extent, and then drawing it back, or even turning it up like the cuff of a coat; secondly, in cutting through the muscles on a level with the retracted skin, and, after detaching them for some distance from the bone, holding them also forcibly back; and, thirdly, in sawing off the bone as high up as possible without doing violence to the soft structures. In executing these several stages of the proceeding, a long amputating knife, poised lightly between the thumb and fingers, is carried rapidly around the limb, the point being inserted into its anterior surface, external to the middle line, and thence drawn towards the operator in such a manner that the heel of the instrument shall finish the incision. The wound thus made extends simply down to the aponeurosis, and care should be taken that it occupies the same level throughout, unless there be special reasons for carrying it higher or lower at one point than another, rendered necessary, it may be, by the presence of a vicious cicatrice, ulceration, gangrene, or some morbid growth. The flap is then rapidly dissected up, either with the same instrument or with a large scalpel, and held out of the way, its length being regulated by the thickness of the limb, about two inches and a half being a good average. The amputating knife being now resumed, and held as before, is applied closely to the edge of the retracted integument, and then drawn around the member so as to divide all the muscles down to the bone, as represented in fig. 207. This part of the

Fig. 207.

Circular Amputation shown in the Leg, the Integument being turned back, and the Muscles divided down to the Bones.

operation is usually the work of a few seconds. The next step is to separate the muscles carefully from their connection with the bone, to the distance of at least an inch and a half, if not more, when, being pressed forcibly back by means of a retractor, the bone is sawed off close to their surface. The adjoining cuts, figs. 208 and 209, afford a good illustration of the appearances of the limb, both below and above the stump, after this operation.

In sawing the bone, whether in this or in the flap operation, it is an object of primary importance to inflict as little injury as possible upon the periosteum; for the less the integrity of this membrane is disturbed the less likelihood there will be of necrosis, myelitis, and other bad consequences. When the periosteum is very thick, as in the thigh-bone, a circular track may be made in it for the saw, to lessen the risk of laceration. The value of the practice of saving a sufficiency of periosteum to cover in the extremity of the bone, followed of late years by certain operators, is not as yet fully determined. The object is to protect the medullary canal against the entrance of pus and other fluids, thereby preventing the occurrence of osteomyelitis, pyemia, and other mischief. Much might certainly be said in favor of the procedure, which, however, is not, by any means, always easy of execution. In every instance the utmost care should be taken to injure this membrane as little as possible with the saw.

The manner of dividing the bone is a matter of some moment. In most of the amputations that I have witnessed the instrument was applied against the front of the bone, instead of being held perpendicularly so as to divide the bone from side to side, as it generally should be to avoid fracture, which is so liable to happen if proper care be not taken to support the limb in this stage of the procedure. Particular rules are usually laid down
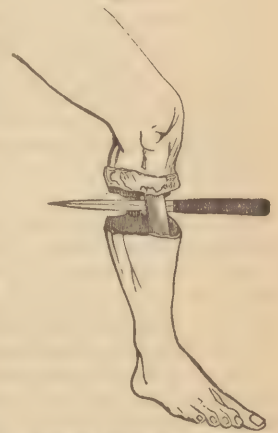
by authors for working the saw. Thus, it is generally stated that the heel alone of the instrument should be used until a sufficient track is made for it; but I consider all such directions as unnecessary, if not frivolous. If the saw is properly set, it is of little consequence, according to my experience, what part is applied first or last, or whether it is moved

Fig. 208.　　　　　　　　　　　　　　　Fig. 209.
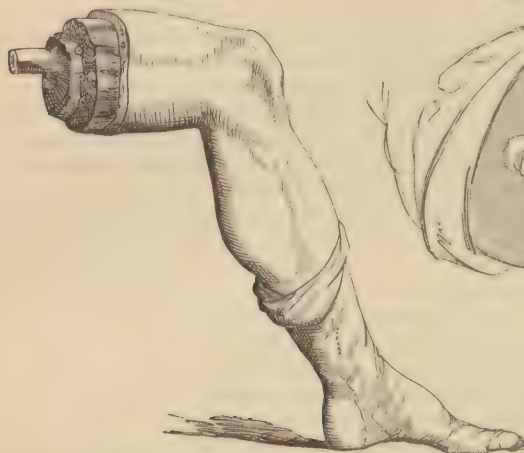
Fig. 208.—Appearance of the Limb below the seat of the Amputation, in the Circular Operation.
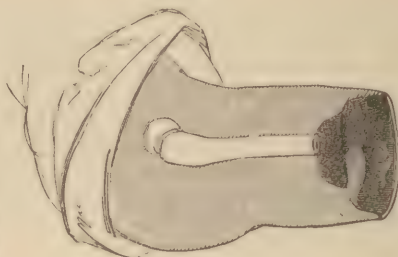
Fig. 209.—Appearance of the Stump in the Circular Amputation.

rapidly or slowly, although, as a matter of choice, I should prefer to finish the operation as quickly as possible. When there are two bones of equal size to be cut, as in amputations of the forearm, they should be divided simultaneously; but if one is thicker than the other, as in the leg, the weaker must always be severed first, lest, if it remain until the other is sawed through, it should be broken or splintered, and so impose the necessity of employing the nippers to smooth its extremity.

When a limb is removed at a joint, the best plan, as a general rule, is to dispense with the use of the saw and the pliers altogether, experience having shown that the preservation of the articular cartilages greatly favors the adhesive process, and thereby expedites the cure. Sawing off the ends of the bones exposes the parts to suppuration, erysipelas, caries, necrosis, and even to the danger of pyemia.

2. *Flap Method.*—Although the flap operation was described, and no doubt practised, by some of the earlier surgeons, it does not seem to have received any particular attention until towards the close of the seventeenth century, when Lowdham, of Oxford, England, published a short tract upon it, setting forth its advantages over the circular method. After this period it was occasionally performed in different parts of Europe, especially in France and England, but it never fully acquired the confidence of the profession until the time of Mr. Liston, whose teachings and writings brought it into general notice.

There are several methods of forming the flaps, the choice of which must be regulated by the particular circumstances of each individual case. Thus, the operation may be performed by transfixion of the limb, and cutting from within outwards; by commencing at the surface, and carrying the knife inwards towards the bone; or, lastly, by making one of the flaps after the former fashion, and the other after the latter. In amputations of the thigh and arm, it is customary to make both flaps by transfixion, as the operation is thus greatly simplified and rendered more expeditious; but in the forearm, hand, fingers, leg, foot, and toes, they are formed either by cutting inwards, or one by cutting inwards and the other by cutting outwards. The number of flaps varies; in general there are two, but occasionally there is only one, and, on the other hand, there may be as many as three; accident, or the situation and structure of the limb, rendering one of these modes preferable to another. Thus, in one instance, I amputated the thigh at its middle by a solitary flap, and succeeded in effecting an excellent cure. The military surgeon is often compelled to form his flaps as best he can, owing to the manner in which the soft parts are injured, and in civil practice the same difficulty sometimes occurs in consequence of the effects of disease or accident. Whatever may be the nature of the case, the rule is never

to include any unsound tissues or any portion of bone that is fractured or divested of periosteum. In amputating the thigh and arm at their middle, the flaps are generally cut of the same length; but in most other situations one is usually made considerably longer than the other, depending upon the greater amount of muscular substance. Their relative length must be regulated by the thickness of the limb, and the quantity, laxity, and contractility of the soft parts. It is better, in every case, to have too much substance than too little, but the judicious surgeon will always endeavor so to cut his flaps as to have just enough, and no more, to form a well-shaped and useful stump, redundancy being always unseemly, if not actually in the way of comfort and convenience. As a general rule, their length should equal about three-fourths of the diameter of the limb, being invariably greater than in a similar operation upon the dead subject, to allow for contraction and shrinkage. The form of the body of the flaps is commonly somewhat convex, while the extremity is more or less oblique, care being taken that they do not terminate in thin, narrow ends, and that there is always an abundance of integument after they are adjusted over the bone. When the muscular tissue is unusually abundant, as often happens in amputating through the calf of the leg, I have found it advisable to retrench it with the knife, in order to give the stump a more seemly shape, as well as to place it in a better condition for bearing the pressure of an artificial limb.

In performing the operation the same general rules are to be observed as in the circular method; hemorrhage is restrained by the same means, and the skin is drawn back by the hands of an assistant, who also retracts the flaps as one after the other is formed, and thus holds them out of the way of the knife and saw. Any important vessels that may be bleeding are instantly compressed by the fingers until they can be tied. Before applying the saw, the knife is passed closely around the bone so as to divide every muscular fibre, and also, if possible, the periosteum. The most suitable instrument for removing the larger limbs is a long amputating knife; for the smaller ones, an ordinary scalpel, bistoury, or catlin will answer best. Separation of the member having been effected, and the vessels carefully secured, the next thing is to cut off the principal nervous trunks a little above the level of the surface of the stump, and, as the operation is one of excessive pain, it should always be performed before the patient has fully recovered from the

Fig. 210.   Fig. 211.

Fig. 210.—The Flap Operation illustrated in the Thigh.   Fig. 211.—The Corresponding Stump; intended to Exhibit
The Sloping Wounds, whence the Flaps have been taken,   the Comparatively Small Extent of Wound that Remains.
shown in the Amputated Part.

influence of the anæsthetic. I need not dwell upon the importance of thus dealing with the nerves involved in the flaps; the necessity of the procedure must be obvious upon the slightest reflection. When it is considered that they always become more or less enlarged and bulbous after all operations of this kind, it is easy to perceive what would be the consequence if they were brought in contact, as some of them almost inevitably would be, with the extremity of the bone, before it has had time to become rounded off. I regard no amputation by the flap method as being finished unless provision has been made against such a contingency. The adjoining cuts, figs. 210 and 211, represent the appearance of the stump and of the limb after its removal.

3. *Oval Method.*—In the oval method, as it is termed by Scoutetten, by whom it has been generalized, or the oblique process, as it has been called by others, the wound has somewhat of the shape of an ovoid, the small extremity of which corresponds to the bone or joint which is the seat of the amputation. The operation holds a kind of intermediate position between the other two, resembling the circular process in the mode of incising the soft parts, and the flap in the form of the wound. It is principally adapted to amputations of the joints, particularly the smaller, as, for example, the metacarpo-phalangeal, but it has also been applied to the joints of the hip and shoulder, especially by Guthrie, Larrey, and Scoutetten, who have devised plans which severally bear their names.

In the oval operation the flaps are formed by cutting from without inwards, or one is formed in this way and the other by cutting in the opposite direction, or from within outwards. It is commenced by making two incisions in the shape of the letter V reversed, the angle of union falling a little above the place where it is intended to saw the bone or effect disarticulation. These incisions are, of course, extended as far as the periosteum, when the knife, drawn closely around behind the bone, is carried downwards on a level with the termination of the two cuts already made, thus connecting them by one thrust, as the instrument sweeps through the intervening tissues. By adopting this plan of procedure the surgeon will have it in his power to leave the principal vessels and nerves until the operation is nearly completed, a circumstance which thus affords him a much better control over the hemorrhage.

The oval operation usually makes an excellent stump, there being always an abundance of material for covering the bone : it is generally a little more tedious than the flap amputation, but this should not be urged as an objection to it, as in all other respects the result is most satisfactory.

4. *Rectangular Method.*—Mr. T. Pridgin Teale, of Leeds, in 1855 modified the double flap operation by substituting a long and a short rectangular flap. The long flap should be made from the portion of the limb which does not contain important bloodvessels and nerves, these being included in the short one. Before proceeding to the operation, the lines of the incision should be traced with ink, in order to insure the proper dimensions of the large flap, which should be equal, in length and breadth, to one-half the circumference of the limb at the point amputated. Thus, for example, if the circumference of the limb be nine inches, the length and breadth of the flap should each be four inches and a half. The short flap, which should be made last, must be one-fourth the length of the long one. The lines of the incisions and the length of the flaps will be more easily understood from the annexed cut, fig. 212, representing an amputation of the thigh. The parts

Fig. 212.   Fig. 213.

Teale's Amputation shown in the Thigh, the Lines
indicating the Size and Form of the Flaps.
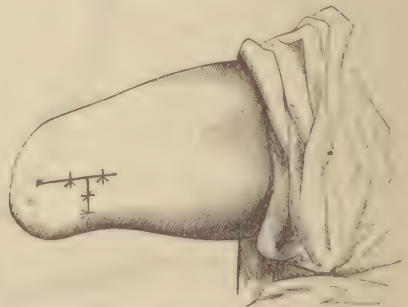
Teale's Operation, the Flaps being Drawn
Together.

having been dissected off, in close contact with the periosteum, the long flap will be found to be perfectly square, and to contain a sufficient amount of movable soft parts to form a complete cushion for the end of the bone, which must be sawed off perfectly straight, and must be free from spicules, in order to prevent ulceration of the soft structures. The arteries having been tied, and the larger nerves retrenched, as in the ordinary flap operation, the long flap is brought down over the end of the bone, and attached to the short one by several points of the interrupted suture. The short flap is also attached to the long flap laterally, as is also the reflected portion of the long flap to its unreflected portion. The dressing is completed by the application of a few narrow adhesive strips. The appearances of the parts, when brought together, are shown in fig. 213.

The rectangular operation makes an excellent stump, furnishing an abundant covering for the bone; but, although this is true, it possesses no advantages whatever in ordinary cases over the common flap amputation, and will, therefore, not be likely to meet with general adoption. If it has any superiority whatever, it is in amputation of the thigh, where, by admitting of a greater saving of bone, it diminishes the risk to life. Unless great care be taken in forming the flaps, and in superintending the after-treatment, there will be danger of non-union, if not also of sloughing, from inadequate nervous and vascular supply.

Mr. Teale, in 1861, published the results of 103 cases of rectangular flap amputations, of which 84 were cured, and 19 died, or in the ratio of 1 in 5.4. Of the whole number 35 were of the thigh, and of these 11 died; 37 were of the leg, with a mortality of 4; 14 of the arm, with 4 deaths; and 17 of the forearm, without any deaths. On comparing these results with those of other amputations, it will be seen that the mortality is very slightly in favor of the rectangular method. It should be added that all the operations were performed at the Leeds General Infirmary by Mr. Teale and his colleagues, Mr. Smith and Mr. Hey.

Mr. James H. Wharton, of Dublin, in 1868, proposed a modification of Mr. Teale's operation, by which the posterior flap is dispensed with, and the bone sawed off on a level with what in the original method would form the lower border of the short flap, the object being to save as much bone as possible. The modification thus proposed has found warm advocates in several Irish surgeons, as Stokes, Mapother, Macnamara, Mayne, and Kelly, all of whom have performed it with the most gratifying results. The chief objection alleged against it is the retraction of the soft parts at the back part of the limb, an occurrence which, so far from being an evil, can always be readily counteracted by proper attention during the after-treatment.

5. *Cutaneous Method.*—Flaps composed exclusively of tegumentary structure are now much in vogue, both in this country and in Europe, even in the larger amputations, as in those of the thigh, leg, and arm. The advantages claimed for them are, first, that, as no muscles enter into their composition, there is less danger of separation of the edges of the wound, and, therefore, a better chance of union by the first intention; secondly, deep-seated suppuration, so common in the ordinary processes, is less frequent; thirdly, the operation is not so often followed by caries, necrosis, neuralgia, and other serious accidents; and, lastly, as the skin, after the completion of cicatrization, is movable over the extremity of the bone, the stump is better adapted to bear the pressure of an artificial limb. The chief objections to the method are, first, the liability of the flaps to slough, especially in cases of injury, attended with more or less contusion; and, secondly, the danger that the stump may eventually become conical in consequence of the retraction of the muscles.

The flaps in this operation may be of equal or unequal length and width, according to circumstances. In some instances one is made quite large, and the other proportionally small, the former being drawn, like a curtain, over the extremity of the bone, as the long flap in the rectangular operation of Teale. In case of accident, three or even four flaps may sometimes be advantageously made; and occasionally, again, the surgeon is obliged to content himself with one, as when the skin is disfigured by a vicious cicatrice, when a chasm has been made in it by an ulcer, or when it has been encroached upon by a morbid growth. However fashioned, they should always embrace as large an amount of connective and adipose tissues as possible, otherwise, their nervous and vascular supplies being thus greatly diminished, there will be danger of sloughing. The length of the flaps must vary, of course, with the diameter of the limb at the seat of the amputation. In an amputation of the thigh in an adult of ordinary stature, it should not, on an average, be less than from three and a half to four and a half inches. The golden rule here, as in all similar operations, is to provide an abundant covering for the bone, a result which may be materially aided by dividing the muscles a little below its level. The stump, after the flaps have been approximated, should be carefully bandaged from above downwards, as a means of preventing retraction. In the after-dressings the flaps should be disturbed as little as possible, as it is all-important that they should speedily unite to the extremity of the bone, in the hope of thereby lessening the risk of the occurrence of osteomyelitis, erysipelas, abscesses, and other serious consequences.

SECT. IV.—OPERATION AND AFTER-TREATMENT.

The position of the patient and the surgeon, the number and duties of the assistants, and the character of the instruments, must necessarily vary in different cases and under different circumstances, and can, therefore, be pointed out here only in a general manner.

The patient should always, if practicable, be recumbent, as he will thus be much less liable to become faint, and at the same time bear the effects of the anæsthetic much better than when he sits up. He may, however, put himself in the latter position without any inconvenience during the amputation of a finger or toe, or even of the arm or leg, if he is courageous, and willing to dispense with chloroform, or to take ether in its stead. The limb, well shaved, is generally held horizontally, away from the table, one assistant retracting the integument, and another supporting the portion to be removed. To prevent the loss of blood, always a great desideratum in an operation of this kind, the limb in all large amputations, should be firmly constricted, either with an ordinary roller, or a gumelastic bandage, as originally suggested by Esmarch, extending from the distal extremity upwards, when the limb should be encircled by a Petit's tourniquet or an elastic band, so as to cause complete stoppage of the circulation. I have satisfied myself that the ordinary muslin roller, if properly applied, answers quite as well in preventing hemorrhage in these operations as the elastic bandage; while it is far less liable to cause serious constriction of the cutaneous capillaries and nerves, and hence less liable to be followed by gangrene of the skin at and around the stump, an effect which is sure to supervene occasionally upon the use of the elastic compressor. An anæsthetic having been administered, the operation is proceeded with in as rapid, orderly, and careful a manner as possible. When the amputation is performed high up near the trunk, the tourniquet or elastic band may sometimes be advantageously replaced by the hands of an assistant, who trusts either to his thumbs alone, or else makes the requisite pressure by means of the handle of a stout key, wrapped around with a piece of muslin. In separating a large limb, not less than five assistants are generally necessary; one for administering the anæsthetic, a second to see to the bleeding, a third to hold up the flaps, one to support the distal portion of the member, and a fifth to hand the instruments and sponges, and aid in securing the arteries. A smaller number will, of course, suffice for the removal of a finger or other insignificant part.

The different methods of amputation are described in the preceding section. The one which I prefer is that by flap, although a most excellent stump may also be made by the circular operation. The rectangular method is well worthy of attention, as the arrangement of the long flap not only thoroughly protects the bone, but, what is of great consequence, admits of ready drainage. The oval operation is admirably adapted to amputations at the joints and to resections of the bones.

My reasons for preferring the flap to the circular operation are, first, because it is more simple and easy of execution; secondly, because it generally affords a much better covering for the bone; and, lastly, because the patient experiences much greater comfort in wearing an artificial substitute.

During the sitting of the commission appointed by Surgeon-General Hammond, to report on the subject of artificial limbs, convened at New York, in 1862, upwards of a dozen manufacturers, then present, unanimously assured me that stumps made by the circular operation are, as a general rule, in every respect, inferior to such as are made by the flap method; that it is much more difficult to fit them with an artificial substitute; and that they are a great deal more liable to become chafed, irritated, and ulcerated. The results of my own observations strongly corroborate this statement. I was at much pains, by visiting some of our military establishments during our late war, to inform myself personally of the comparative merits of the two operations, and, from all that I witnessed, I am satisfied that the preponderance is vastly in favor of the flap method. Dr. R. J. Levis, in charge of the government hospital in this city for the cure of bad stumps, during our late war, bears similar testimony.

The principal instruments required for the operation are, for the larger limbs, a tourniquet, or Esmarch's apparatus, described on page 489, an amputating knife, a catlin, saw, and pliers, which are properly arranged upon a tray in the order in which they may be needed. For removing the fingers, hand, toes, or foot, an ordinary scalpel will commonly suffice. The tourniquet in general use is that of Petit, the construction and arrangement of which may be readily learned from the annexed sketch, fig. 214, a circumstance which, besides the fact that it is found in every cutler's shop, renders any formal description of it unnecessary.

The tourniquet of Petit has been modified by Mr. Tiemann, of New York, in such a manner as to concentrate a much greater amount of pressure upon the artery, at the same

time that it does not embarrass the venous circulation.   The pad is placed either horizontally or crosswise upon the vessel, and the strap, carried round the limb, is passed through

Fig. 214.

Fig. 215.

Tiemann's Improved Tourniquet.

Petit's Tourniquet.

the two side apertures in the metallic plate, after which the ends are drawn very tight, and fastened on the protruding hooks.   The arrangement of the different pieces of the instrument is seen in fig. 215.

Fig. 216 represents an arterial compressor devised by me in 1856, as a convenient substitute for the ordinary tourniquet, over which, I conceive, it possesses several decided advantages; first, in the facility of its application; secondly, in the amount of pressure which it is capable of exerting; thirdly, in its ready adaptation to limbs of different dimensions; fourthly, in the circumstance that it makes pressure only at two points, that is, over the artery, and at the spot immediately opposite to the artery; and, lastly, the facility with which it may be slackened or removed at any stage of the operation.   With a little modification, the instrument may readily be adapted to the femoral artery as it emerges from beneath Poupart's ligament, or even to the external iliac just above this ligament, in amputation at the hip-joint, and also to the axillary artery, in disarticulation of the shoulder-joint.

Fig. 216. .

Artery Compressor.

The instrument, as will be seen by reference to the cut, is composed of two blades, differing in the degree of their curvatures, united by a screw, and regulated by a ratchet. Each short blade is provided with a pad, controlled by a screw, and designed to rest upon the artery which it is intended to compress.   By this arrangement two tourniquets are formed : a large one for the thigh, and a small one for the arm, or the thigh of a small subject.

The ordinary amputating knife, fig. 217, is from nine to twelve inches in length, by about five lines in width, with a moderately thick back, spear-pointed, and furnished with a stout, rough, ebony handle, to prevent it from dropping out of the hand if it should become smeared with blood.   The principal edge should extend the whole length of the blade, and be in the best possible condition for executing its important office, well tempered, and perfectly sharp.   The edge upon the back should not be longer than an inch and a half.   With such an instrument, properly managed, nearly all the amputations of

the body may be performed with great neatness and celerity. The catlin, shown in fig.
218, is a double-edged knife, used principally in removing the forearm and leg, and for

Fig. 217.

Amputating Knife.

dividing the interosseous muscles and ligaments : I cannot see, however, that it possesses
any special advantage, even in these cases, over the larger knife just described.

Fig. 218.

Catlin, or Double-edged Knife.

Every amputating case contains a large saw, resembling the common dove-tail saw of
the cabinet-maker. The adjoining sketch, fig. 219, represents the form of the instrument,
which I am myself in the habit of using. The blade, which is very firm, is ten inches
and a half in length at the cutting edge, by two inches and one-eighth in breadth, exclu-

Fig. 219.
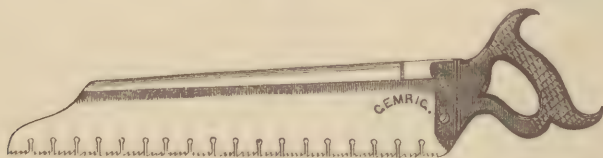
Amputating Saw.

sive of the back, which is very thick and convex, in order to afford the proper degree of
strength which such an implement should always possess. The handle is rough, and
sufficiently large to receive two fingers, while the thumb and forefinger are applied to its
surfaces, parallel with the upper border, to keep it steady while engaged in the discharge
of its duty. The teeth are rather large but sharp, and set crosswise on the edge, that the
instrument may not hang or hitch as it works its way through the bone. The manner of
using the saw has already been described. What is known as Butcher's saw, represented
in the chapter on excision, is now generally put up in our amputating cases, and is by
many surgeons preferred to the saw there described. It is certainly a very excellent
instrument.

A small saw, such as is represented in fig. 220, will be of great service in amputations
of the hand and foot.

Fig. 220.

Small Amputating Saw.

Cutting pliers, fig. 221, of various sizes and forms, must be at hand; they should be
short but rather slender in the blades, and very long and strong in the handle. Although
I never use these instruments when it is possible to employ the saw, on account of their
tendency to bruise the osseous tissue, yet they are of great convenience for removing sharp
spicules, and cutting off certain pieces of the skeleton, as the phalanges of the toes and
fingers, the ribs, and the jaws.

The limb being removed, and the nerves, if necessary, retrenched, every bleeding artery
is promptly secured, commencing with the main trunk and then tying up successively each
smaller branch until the flow of blood is effectually arrested.

It is seldom that more than from four to six arteries require to be tied, especially when
the operation is performed on account of recent injury. When, on the contrary, a limb

is removed on account of a morbid growth, as, for example, a sarcomatous tumor, elephantiasis, or chronic inflammation, the smaller arteries are often immensely enlarged, and may, therefore, each demand separate attention. A similar arrangement generally exists when the main artery of a limb has been obliterated, whether designedly or acci-

Fig. 221.

Bone Nippers.

dentally, for then all the anastomotic branches carry an unusual amount of blood to atone for the loss sustained by the interruption of the principal channel. Hence we occasionally hear of cases in which as many as twenty, thirty, and even forty ligatures were applied before the hemorrhage could be completely arrested. Such a necessity is always to be regretted on account of its liability to be followed by serious inflammation and suppuration from the irritation of so much foreign material.

Hemorrhage of a troublesome kind often arises when the flaps in an amputation are taken from parts recently in a state of inflammation, as the arteries are then firmly embedded in the tissues by partially organized plasma, and so rendered incapable of retracting and of being drawn forth with the forceps or tenaculum. When this is the case the vessels must be separated with the knife, or controlled by acupressure.

Not a little trouble is often experienced in checking the flow of blood from the veins, especially in amputations of the thigh and leg, performed on account of chronic disease, as old ulcers, long-continued inflammation, and various morbid growths. When this is the case, the bleeding vessels, which are sometimes quite varicose, may either be tied in the same manner as an artery, compressed by means of a long needle, as in ordinary acupressure, or occluded with a very small pair of forceps, as suggested by Mr. G. H. Porter, of Dublin, the instrument being removed at the end of forty-eight hours. Great prejudice exists against ligating veins, but experience has shown that the fears that are entertained upon this subject are, if not entirely ill-founded, greatly exaggerated. The largest veins, as the internal jugular and femoral, have repeatedly been tied with impunity. I have myself never hesitated to adopt this treatment when occasion seemed to demand it; and in no instance, so far as I remember, have any evil consequences ensued. The testimony of other surgeons is equally conclusive upon the subject.

That the fears of exciting dangerous inflammation of the veins by the application of a ligature are utterly groundless, has been conclusively demonstrated by Dr. S. W. Gross, in an elaborate communication in the American Journal of the Medical Sciences for January and April, 1867. Of forty cases of ligation of the internal jugular vein, analyzed by him, death was fairly ascribable to the ligature in only four, all due to secondary hemorrhage, coming on about the time of the separation of the thread. In not a single instance was diffused phlebitis excited. Since the publication of his paper, Dr. Gross has analyzed twenty cases of ligation of the external jugular vein, and fifteen of the axillary vein, which add additional testimony to the safety and efficiency of the ligature, inasmuch as all did well.

The troublesome bleeding which occasionally proceeds from the nutrient artery of the bone is usually easily arrested by plugging the orifice temporarily with a piece of soft wood, or a little tampon of lint attached to a thread. The oozing from the end of the bone sometimes requires the application of a lint compress, but, in general, it speedily stops of its own accord, or under the influence of the contact of cold air, or hot water. The sponge occasionally used in this form of hemorrhage is objectionable, as it is liable to contract firm adhesions, rendering its separation difficult, and endangering the occurrence of osteomyelitis and the rapid healing of the stump.

After-Treatment.—As it respects the permanent dressings after amputation, they should be of the lightest and most simple character. In the larger operations they should not, as a rule, be applied under four or five hours, or until the wound is well glazed with lymph, and all danger of hemorrhage past. It is difficult to conceive of anything more awkward for the surgeon, or more disagreeable to the patient, than the necessity of undoing the dressings, some hours after the removal of a limb, for the purpose of searching for bleeding vessels. Such a procedure is sure to cause alarm and suffering; and, although it is

always, in ordinary cases, desirable to complete the dressings as early as possible, yet after a large amputation, involving vast and numerous muscles liable to conceal arteries of considerable size, I regard it as a matter of great consequence not to hazard the necessity of their removal. During the period that intervenes between the operation and the permanent dressings, the limb should be placed in an easy, elevated position, and the flaps should either be loosely approximated with a few adhesive strips, or, what is better, left apart, and covered with light compresses wet with cold water, and frequently irrigated; not changed, unless soaked with blood, as this would only lead to exposure and irritation of the parts.

The rules here laid down are chiefly applicable to amputations in civil practice. In operations of this kind performed on the battle-field no such delay is, of course, admissible.

All bleeding and danger of bleeding having ceased, the flaps are carefully stitched in place, the ligatures are brought out at the nearest points, and the intervals between the sutures are covered with long and rather narrow strips of plaster, to admit of proper drainage. This should be still further favored, when the breach is very large and deep, by the insertion of a slender tent in the lower angle of the wound, and by strict attention to the position of the stump. To a want of these precautions are unquestionably to be ascribed some of the bad effects of these operations, as septicemia, profuse suppuration, and the death of the extremity of the bone. The wound being firmly closed at all points the matter, of which there is nearly always more or less after all large amputations, accumulates in the depths of the stump, around the bone, and among the muscles, thus causing necrosis of the former, and affording the veins and lymphatics of the latter an opportunity of conveying the fluid into the system, and thereby inducing blood-poisoning. All this risk may be effectually prevented by adopting the plan here suggested of keeping a long, slender, and well-oiled tent in the lower part of the wound for the first thirty-six or forty-eight hours; at the end of this time it may be carefully removed, and any pus that may be present gently pressed out. A gum-elastic tube may now, if necessary, take the place of the tent, with a view to more ready and steady drainage, or, if the suppurative crisis is passed, the foreign body may be dispensed with, and the case managed in the ordinary way.

When numerous ligatures are required to arrest the bleeding, as in some of the larger amputations, performed on account of chronic disease or morbid growths, the best plan is to bring out their extremities at the nearest points of the flaps, instead of at the edges of the wound, by means of a large, long, slender needle. Such a procedure will not only abridge suffering, but greatly promote the chances of primary union. Chromicized catgut ligatures, to which I have recently resorted in all my amputations, are preferable to the ordinary ligature, and will, doubtless, come into general use.

The adhesive strips must, if possible, extend four or five inches beyond the upper extremity of each flap, especially in the larger amputations, so as to prevent the retraction of the integument, and also for the purpose of quieting the muscles and bringing them well forward over the bone. I have been in the habit for many years of beginning the application of the roller at the part of the limb nearest to the trunk, carrying it firmly and equably downward to the very verge of the stump, which is then enveloped by a few crucial turns of the bandage, to give it greater support. No other dressing is necessary. The limb is placed in an easy and slightly elevated position, upon a pillow or splint covered with oil-cloth, and kept constantly wet with cold water, applied by means of a light, porous towel, renewed whenever it becomes in the slightest degree bloody or offensive. If suppuration be threatened, or the cold is disagreeable and chilling in its effects, the most eligible substitute will be an emollient cataplasm or warm water-dressing medicated with lead-water and laudanum. The stump is of course carefully protected from the contact of the bedclothes. As soon as the operation is over, a full anodyne is ordered, for the twofold purpose of relieving pain and preventing spasm, the dose being afterwards repeated from time to time as circumstances may seem to demand. The diet should be light, but rather nourishing than otherwise; and, with the exception of a mild aperient on the second day, no medicine whatever should be given unless it is absolutely necessary on account of the violence of the traumatic fever, or the danger of exhaustion from shock and hemorrhage. When the system is much depressed at the time of the operation, the patient should at once be put upon the use of quinine and iron along with a generous diet, aided, perhaps, by milk punch. From what I have seen of such cases, I am satisfied that the worst possible plan that can be pursued is starvation, as this not only weakens the system still further, but tends powerfully to the production of pyemia, erysipelas, and typhoid fever.

The dressings may require removal within twenty-four, thirty-six, or forty-eight hours

after the operation, or not under three or four days, according to the condition of the parts. When the adhesive action is progressing favorably, the less interference there is the better, any discharge that may collect on the surface of the stump being soaked up with a soft sponge. If considerable swelling and pain take place, or profuse suppuration set in, the change cannot be effected too soon or too frequently, the limb being well supported while this is being done by an assistant, at the same time that all pressure and unnecessary manipulation are avoided. Any tendency to bagging is to be counteracted by the judicious application of adhesive strips and the bandage, aided by declivity of the stump, so as to favor drainage, now of vital importance both to the part and system. Permanganate of potassium or chlorinate of sodium is freely used as a stimulant and a deodorizer. The sutures should not be cut out too soon; as long as they are affording support they should be permitted to remain.

The antiseptic and cotton-wool dressings, to which reference is made on page 346, are much employed in this class of cases; but as I do not believe that they possess any advantages over the simple treatment which I have just described, I never resort to them.

A mode of treatment, known as pneumatic aspiration, intended to exclude the air from the stump, has been extensively practised in some of the Parisian hospitals, especially in the wards of the Hôtel-Dieu, by Maisonneuve, its inventor. It simply consists in surrounding the stump with a closely-fitting hood of vulcanized India-rubber, to the centre of the free extremity of which is attached a tube, of similar material, from two to three feet in length, the opposite end of which is fitted, by means of a metallic canula, in a rubber plug secured in a gallon glass jar. "A second metallic tube pierces the India-rubber plug, and is connected with a vulcanized tube, of convenient length, attached to a brass exhausting pump. A few strokes from the piston morning and evening suffice to draw the discharges from the stump into the jar, where, in the absence of air, they accumulate without danger of decomposition; while the healing of the wound is facilitated by the accurate and immovable adaptation of its surfaces, and the exclusion of air." It is proper to add that the edges of the wound are held together simply with adhesive plaster, unaided by sutures.

Of the efficacy of this mode of treatment facts are still wanting to enable us to form an accurate opinion. Mr. Gamgee, of Birmingham, who has called the special attention of English surgeons to it, speaks of it in very flattering terms, and in the hands of its inventor it seems to have already achieved great success.

The treatment of amputation by the "open method," as it is termed, orginated by Burow, of Germany, and introduced into this country nearly simultaneously by Dr. J. E. Link, of Indiana, and Dr. James R. Wood, of New York, deserves more consideration than has hitherto been accorded to it. My conviction is that, as a rule, it is preferable to every other plan that has ever been devised; more rational, more safe, and more free from the risk of complications and bad consequences. Dr. Link, in 1875, reported 190 cases of amputations treated in this manner, 150 in military, and 40 in civil, practice, with results eminently gratifying; and Dr. Wood, who introduced the method many years ago, at Bellevue Hospital, has achieved with it the most remarkable success. In nearly one hundred operations of this kind performed upon the upper and lower extremities, including the wrist, elbow, shoulder, ankle, and knee-joints, there was not one death which, as he informs me, could justly be ascribed to blood-poisoning, or to the exposure of the stump to the air, although, as a rule, his patients were in an indifferent physical condition, and often in bad hygienic surroundings. He lays great stress upon the manner in which the amputation is performed; his flaps, which are either lateral or antero-posterior, are entirely cutaneous, every particle of muscular substance being excluded, and everything is done with reference to thorough drainage. The "open method" has found warm advocates in Professor Humphry, of Cambridge, and in Mr. Teale, of Leads; and it may safely be predicted that the day is not distant when it will be generally adopted.

In this mode of dressing, the flaps are left completely open, sutures, adhesive strips, and bandages being dispensed with during the first week. The wound is washed immediately after the operation with a moderately strong solution of carbolic acid, and then filled with balsam of Peru, the drainage, as practised by Dr. Wood, being completed by interposing between the flaps a pledget of oakum soaked in the balsam. The stump is left in this condition during the first twenty-four hours, unless it become hot or painful from overaction, when it must be removed at once. After this period the wound is washed twice daily with weak carbolized water by means of a douche or syringe, and treated with balsam and oakum as in the first instance. When the suppuration has nearly ceased, as it usually does by the end of the sixth or eighth day, the flaps are moulded into shape, and gradually

approximated with adhesive plaster. As this mode of treatment is attended with an un-
usual shrinkage, the flaps must be made proportionally large. The "open method," while
admitting of free drainage, leaves an excellent stump, and is not liable to be followed, as the
ordinary close dressing, by erysipelas, abscesses, pyemia, septicemia, or suppurative fever.

The ligatures should be removed as fast as they are detached, with as little injury as
possible to the vessels and other structures. Their unnecessary retention is a great evil.
That around the main artery will generally come away last, and special care should be
taken not to make any undue traction upon it, as its premature separation might be fol-
lowed by serious, if not fatal, bleeding.

Secondary hemorrhage occurring after amputation must be treated upon general prin-
ciples; by the ligature, if this be practicable, at the stump; by styptics, as the subsulphate
of iron; or by the compress, applied either directly to the orifice of the bleeding vessel,
the wound having previously been thoroughly dried, or indirectly over the course of the
affected vessel. The latter expedient is often successful after amputation even of the
larger limbs. When everything else fails, the only resource is ligation of the main artery
of the extremity some distance from the seat of the operation.

After the wound has healed, the stump should be protected for some time with a piece
of soft flannel, to prevent the ill effects that might otherwise arise from atmospheric vicis-
situdes; and all pressure upon its surface should be carefully avoided until the parts have
regained their natural sensibility.

Synchronous Amputations.—In cases of accident, as well as in certain diseases, but
especially in the former, it occasionally become necessary to amputate two limbs simulta-
neously, or in immediate succession, the circumstances which call for the removal of the
one demanding the separation of the other. This constitutes what is termed the synchro-
nous double operation. It is founded upon the assumption that recovery is more rapid
when two limbs are cut off simultaneously than at two separate and distinct periods; that
the loss of blood will be comparatively little more from two amputations thus performed
than from one alone; that there will be in the aggregate, much less pain, shock, and
inconvenience; and, lastly, that the patient will thus escape the harassing anxiety of mind
growing out of the knowledge that he will be obliged to submit to another operation.
Synchronous double amputation has occasionally been performed in various parts of this
country and Europe; but, so far as my information extends, it was first adopted, as a rule
of practice, by the surgeons of the Hôtel-Dieu, at Quebec, the first case having occurred,
many years ago, in the hands of Dr. Morris, of that city. Within the last twenty-five
years the operation has also been performed by Dr. Carnochan, Dr. S. W. Gross, Robert
H. Seiler, Paul F. Eve, Amerman, and a number of other surgeons. In 1847, Dr. John
G. Koehler, of Schuylkill Haven, Pennsylvania, removed simultaneously, on account of a
railway injury, both legs and one arm from a lad, thirteen years of age, recovery taking
place without the supervention of any serious symptoms. The limbs were frightfully
crushed, and the operation was performed within a short time after the accident. The
arm being cut off first, the pulse immediately sank, but under the influence of stimulants
it rose sufficiently in five minutes to justify amputation of both legs below the knee. So
excessive had been the shock of the system that the boy hardly experienced any pain
during the operation. Professor Stone, of New Orleans, had a similar case, equally
successful, in a man, thirty-three years of age, the subject of a railway accident. Dr.
Alfred Müller, of the army, in 1866, amputated both arms on one day, and both legs on
the next, on account of frostbites, the patient making an excellent recovery. Mr. Begg,
of Dundee, Scotland, in 1869, amputated all the extremities in a young woman on account
of embolic gangrene, and she not only recovered but has since been able to walk with the
aid of crutches, and to earn a livelihood by knitting and various other kinds of work.
She feeds and dresses herself, and writes an excellent hand. This case, apart from its
pathological value, as indicating how life may be saved by judicious interference in
embolic gangrene, is of special interest as showing how lost parts may be supplied by
ingenious mechanical contrivances, so as to be of great use to an individual who would
otherwise be wholly helpless. Professor Ashhurst, in 1879, removed successfully, on
account of railway injury, the left leg at its middle and the right lower extremity at the
hip-joint, from a boy thirteen years of age.

The synchronous double operation may be performed by two surgeons, or by one alone,
the latter being perhaps the preferable method. In either event, it is a matter of para-
mount importance to protect the patient from the loss of blood, the slightest effusion of
which might prove prejudicial to his safety. Dr. Carnochan cuts off both limbs before

he ties any vessels, and this is undoubtedly the preferable plan if we can be certain of having perfect control over the hemorrhage, as when proper assistants are at hand, and the removal is effected rapidly by the flap operation. Synchronous amputation of the lower extremities may be performed with very little loss of blood, with the aid of the abdominal tourniquet.

The prognosis of synchronous double amputations is, of course, for obvious reasons, more unfavorable in the lower extremities than in the upper. Experience shows that the operation, when performed for gunshot injuries through both legs, knees, and thighs, is nearly always fatal. Both feet, hands, arms, and forearms, on the contrary, may generally be removed with comparative impunity.

Reamputations.—Such operations may become necessary on account of the bad shape of the stump, as when it is too square or too conical, great retraction of the skin and muscles leading to protrusion of the bone, extensive caries of necrosis, ulceration of the soft parts, and hypertrophy of the nerves, attended with neuralgia and exquisite morbid sensibility. The suffering that may be caused by some of these affections may not only greatly interfere with progression and the use of an artificial limb, but seriously impair the general health and render life perfectly miserable. I have seen cases where the extremity of the stump was so irritable as to be intolerant of the slightest touch, the patient screaming and wincing as if he had been electrified.

A second amputation should be performed upon the same principles as a first one. If the general health is much deranged, the knife should be withheld until it has been rectified, otherwise serious, if not fatal, consequences may ensue. Instead of amputation, resection may sometimes be advantageously performed, the offending parts being removed either with the scalpel, or the scalpel and pliers. Hemorrhage is carefully guarded against, as the slightest loss of blood may prove highly prejudicial.

The question has of late years been much agitated, whether, when the bone of a stump is extensively diseased, it would not be better to exarticulate the limb than to reamputate in its continuity? Valette and Roux, two eminent French surgeons, of large experience as military practitioners, have expressed themselves warmly in favor of the former procedure, on the ground that there is always great danger, when a bone has been affected with osteomyelitis, of a persistence of the morbid action, despite every possible precaution that may be used in the removal of the limb in its continuity. The cases under the care of Valette were, it would seem, principally of an acute character, while in those of Roux the disease had attained its chronic stage. The practice advocated by these surgeons cannot, in my judgment, be too strongly condemned, as it is alike harsh and hazardous. In acute myelitis, the proper course, as a general rule, is, to wait until, under appropriate local and constitutional measures, the disease is effectually arrested, when the mere extraction of the sequester will commonly suffice to effect a cure. If this do not answer the purpose, the bone may be safely excised, or the limb may be reamputated in its continuity, an operation especially indicated when, superadded to the disease of the bone, there is serious lesion of the soft parts, or a very defective condition of the stump from loss of substance. If it be said that the patient cannot, from the drain and irritation consequent upon such an affection, successfully struggle through the period necessary for the arrest of the morbid action, it may be replied that such an occurrence, although possible, is not probable, and that it must, therefore, be viewed as an exceptional circumstance.

As it respects the chronic form of osteomyelitis, I am satisfied, from personal experience, that exarticulation, so ably advocated by Roux, can only be required in exceptional cases. Ordinarily, it will be quite sufficient to remove the sequester, to excise the bone, especially if it be carious and disintegrated, or to reamputate in the continuity of the limb. With this statement the results of the observations of our army surgeons fully coincide. Dr. Richard J. Levis, during his connection with the large government hospital of this city for the treatment of diseased stumps, was not obliged to exarticulate in a single instance. He always accomplished his object by the adoption of some one of the operations here specified.

I am aware, as is every surgeon of experience, that, in chronic osteomyelitis, the part and system become inured to suffering, and, consequently, more tolerant of interference; but this, surely, is no valid reason for substituting so hazardous an operation as exarticulation for one so simple as the extraction of a sequester, the excision of a carious bone, or even the amputation of a stump in the continuity of a limb.

It is not often that a limb is obliged to be reamputated more than once on account of a bad stump. The existence of neuralgia requires such interference, perhaps, more

frequently than any other affection. At all events, it is in this class of cases that the operation has most commonly been performed. Instances have been reported in which one part of an extremity after an other has been sacrificed for the relief of this disease, and yet no ulterior benefit accrued even after amputation at the shoulder or hip-joint.

Spontaneous Amputations.—Under this head may be briefly described those amputations which occasionally occur during utero-gestation, in consequence of the constriction of a limb by a cord or band of plastic matter. Such accidents, which are, surgically considered, of comparatively little interest, are usually designated by the term "spontaneous," and are liable to take place in the upper as well as in the lower extremities, in the larger as well as in the smaller limbs. The division is sometimes complete, at other times partial.

The cause of this occurrence was for a long time a mystery. The prevalent opinion, up to a comparatively recent period, was that it was due to gangrene developed during fœtal life by some agent, the precise nature of which no one could explain. Unfortunately, however, for this view of the case, no evidence was ever discovered, either in the amputated limb or in the stump, of the existence of such a condition, and, consequently, the notion was at length abandoned. It remained for Professor Montgomery to solve the enigma. In a paper published in the Dublin Journal of Medical Science for May, 1832, he distinctly asserted that the agency by which the lesion is produced is a cord or band of false membrane, thrown accidentally around a limb, acting on the principle of a string, drawn more and more tightly by its own contraction, until, if the pressure be continued, complete severance of the tissues, hard as well as soft, is effected. That this explanation is correct is, I think, unquestionable. The fact that lymph is liable to be poured out by the surface of the child, by the placenta, and by the umbilical cord, during pregnancy, is well established, and every pathological anatomist knows how prone such matter is, when it has become organized, to contract and shrink. This tendency to contract and shrink steadily increases with the age of this substance, and, hence, it is easy to conceive how a cord or band of membrane might, if drawn firmly around an arm or leg, eventually lead to its separation. Zagorsky has published a drawing of a case which affords an excellent illustration of partial and complete amputation of the leg by a process of this kind. The foot of the severed limb is suspended, as it were, from the centre of the fibrous cord. The fœtus, which had attained the fifth month, was greatly deformed in the head and hands, especially the left. In a remarkable instance described in the London Medical Times and Gazette for 1853, intrauterine amputation took place in all the limbs. The child was born alive, and was in all other respects well formed.

The stump after such an occurrence is not always well shaped, and may, therefore, if the child survive its birth, require retrenchment or improvement. In general, however, it is perfectly cicatrized, and sufficiently seemly. Now and then inconvenience is experienced by the protrusion of a piece of bone, the removal of which is followed by a speedy cure.

SECT. V.—AFFECTIONS OF THE STUMP.

These affections are either of a primary or consecutive character, and both may be purely of a local, or of a local and constitutional origin. The primary consist of hemorrhage, spasm of the muscles, excessive pain, undue inflammation, osteomyelitis, and inordinate retraction of the soft parts, thereby permitting exposure of the bone. Among the secondary effects may be mentioned necrosis and exfoliation of the bone, degeneration of the nerves and neuralgic pain, aneurismal enlargement of the vessels, and contraction of the tendons in the neighborhood of the stump, by which the latter is drawn out of its proper position, and so made a source of inconvenience and discomfort.

1. PRIMARY AFFECTIONS.

a. Hemorrhage may come on soon after the dressing of the stump, or not until some time has elapsed; perhaps not for several days. It is usually occasioned by the want of a sufficient number of ligatures, in consequence of the retraction of some of the smaller arteries, thereby escaping the surgeon's attention while he is looking out for the principal and more accessible branches; or it may be that the vessel has been cut obliquely, and that it has not been tied high enough up; or that the arterial tunics are so much diseased as to give way under the pressure of the cord before the formation of an adequate internal clot, as when the bleeding supervenes several days after the operation; or, finally, that the vessels are embedded in inflamed tissues, and, consequently, incapable of retraction.

However induced, or whatever may be the circumstances which give rise to the hemorrhage, the proper remedy consists in exposing the open artery, and securing it with a ligature, either by separating the flaps, or, if adhesion is already far advanced, by dilating the canal along which the blood flows over a grooved director. The main artery of the limb is not tied unless it be found impossible, on account of disease, or some other cause, to effect ligation at the stump.

Sometimes the hemorrhage is purely venous, the blood flowing away lazily in a dark purple stream, without any jet, and then it will generally be found to depend upon the want of accurate coaptation of the flaps, or some defective application in the bandage, making either too little or too much pressure ; in the former case keeping the vessels open and gaping, in the latter interfering with the passage of their contents. Occasionally the blood oozes out at different points, as water oozes out of a sponge, and this may take place either from the soft parts, or from the Haversian canals of the bones, or from the medullary membrane and the marrow. Arrest of the bleeding is usually effected simply by compression of the stump, the compress and roller being made to bear steadily against the offending vessels, aided by elevation and cold applications; when this fails, the ligature may be required. When the blood proceeds from the Haversian canals, it will generally be necessary to undo the flaps, and apply a compress directly to the surface of the bone, the wound being kept open until the flow is arrested. Caustic applications must not be used, as they might cause necrosis.

β. *Spasm* of the muscles, which is frequently a source of deep distress, and which presents itself in the form of jerks or twitchings, usually sets in within a few hours after the operation, and is generally most severe in persons of a nervous, irritable temperament. No patient, however, is ever entirely exempt from it after amputation, and it is always sure to be materially aggravated on the occurrence of inflammation. In regard to treatment, much is to be done in the way of prophylaxis ; by the judicious use of the roller to give equable support to the muscles of the stump, by elevation of the part to favor venous return, and also by the early exhibition of a full anodyne. The use of morphia, or of morphia and antimony, along with warm fomentations, will be required if the spasm is at all severe, as when no such precautionary measures have been adopted. In most cases prompt relief may be afforded by the subcutaneous injection of morphia.

γ. The degree and continuance of the *pain* which follows an amputation will be influenced very materially by the character of the case, the size of the limb, the presence or absence of complications, and, above all, by the temperament of the patient. Coming on usually as the system emerges from the influence of the anæsthetic, it is sometimes remarkably slight, while at other times it is so severe as to require large quantities of anodyne medicines for its relief. When the pain is associated with spasmodic twitching of the stump, as it generally is during the first twenty-four hours, it must be promptly met with anodynes, or anodynes and antimony. In order to render these two phenomena as light as possible, I have long been in the habit of administering a full opiate about two hours before the operation, and have never been disappointed in my expectations.

δ. The *inflammation* consequent upon an operation of this kind may be either of the ordinary character, or it may be erysipelatous, the determining circumstances not being always appreciable. In general, however, the danger of erysipelatous action will be considerable when there has been severe shock or excessive loss of blood, conjoined with previous bad health or habits of intemperance. It usually makes its appearance within the first forty-eight hours, and is characterized by the ordinary phenomena, such as a red, dusky state of the skin, more or less throbbing, a sense of tension, and burning, smarting pain, with marked disorder of the general system. Whatever may be the degree or character of the inflammation, it is always hostile to the adhesive process ; some parts may, it is true, unite in this way, but suppuration will be almost sure to follow, so as to lead to the necessity of healing the greater portion of the wound by granulation. In persons of a very dilapidated constitution the inflammation may pass into gangrene. I have found this termination most commonly in patients of a scrofulous habit of body and in those whose system has been contaminated by syphilis.

When the suppuration takes place, as it will be very apt to do when there is much inflammation, the matter is often widely diffused, burrowing extensively along the intermuscular spaces to a great distance up the stump. This is particularly liable to happen in amputations in the lower part of the forearm and leg, the hand, and tarsus, owing to the numerous synovial sheaths in those situations readily permitting the entrance of the pus.

Gangrene is often quite common after amputations in crowded military hospitals and barracks, and on board transports, from the vitiated condition of the atmosphere, and the generation of noxious emanations, which, rapidly depressing the vital powers, induce a low form of fever, and cause every wound, sore, or ulcer, however insignificant, to assume an unhealthy, sloughing appearance.

The treatment of this disease must be conducted upon general antiphlogistic principles. Special attention must be paid to the state of the system, and with this view it will generally be necessary to employ a mildly stimulating course, consisting of quinine and milk punch, with blue mass and ipecacuanha to evacuate the bowels and correct the secretions. Morphia is given in liberal doses to allay pain and procure sleep. The most suitable local remedies are dilute tincture of iodine, and fomentations or cataplasms medicated with solutions of acetate of lead and opium. Leeches generally prove prejudicial. Sometimes the disease is promptly arrested by the application of a large blister. Inordinate tension and confined fluids are relieved by puncture and incision. Abscesses are opened and sinuses traced out in the usual manner, infiltration of pus being always zealously guarded against. Counteropenings are made wherever they are likely to be useful, as affording a more ready exit to the pus. If mortification is threatened, the parts are freely touched with nitrate of silver, sulphate of copper, or dilute acid nitrate of mercury, and enveloped in a fermenting poultice. The chlorides are used for allaying fetor, and the syringe for washing away secretions from beneath the flaps.

ε. Bad effects occasionally follow amputation as a result of *osteomyelitis*. In the Crimean war this affection was of such frequent occurrence after gunshot injuries that the question was at one time seriously debated by a number of surgeons whether it would not be best to abandon amputation altogether in the continuity of the larger bones, and resort to disarticulation as a substitute. The disease is also sufficiently common in hospital and private practice, especially in railway and other severe accidents, attended with violent concussion of the osseous tissue. The probability is that it is occasionally caused by injury inflicted in sawing the bone. However induced, it generally sets in within a short period after the operation, so that by the time the dressings are removed, as they usually are on the third, fourth, or fifth day, it is found to have already made considerable progress, the marrow being of a brownish, blackish, or greenish appearance, of a soft, putrilaginous consistence, excessively fetid, and partially detached from the bone, which is itself either dead, or in a dying state, and more or less denuded of periosteum. The disease is generally attended with considerable pain, although in some of the cases that I have seen there was almost an entire absence of local suffering. It is not unfrequently coincident with pyemia and erysipelas. Hence the prognosis is often exceedingly unfavorable.

The treatment of osteomyelitis must be antiphlogistic, modified by the peculiarity of the constitutional symptoms. Great attention must be paid to cleanliness; the dressings must be frequently changed, and free use made of weak solutions of chloralum, permanganate of potassium, or thymol. The judicious application of nitrate of silver to the affected structures might possibly assist in circumscribing and ultimately arresting the morbid action. If the bone die, no attempt should be made to remove it until the part and system have sufficiently recovered from the effects of the disease to bear the shock of the operation.

ζ. Finally, amputation is occasionally followed by inordinate *retraction* of the muscles, so as to uncover the bone, and, perhaps, lead to the necessity of its removal. The acci-

Fig. 222.
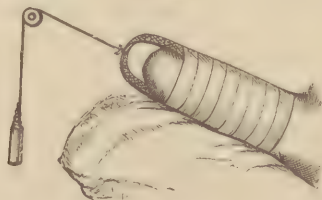
Thigh Stump, with Splint for Extension.

dent is most liable to happen after amputation of the thigh, in consequence of the action of the numerous, large, and strong muscles in that situation, and cannot always be pre-

vented even when more than ordinary care is taken in forming the stump.   The occurrence is always to be deprecated, inasmuch as it not only interferes with the union of the flaps, but is very apt to cause the death of the bone.   The remedy consists in bandaging the limb firmly from above downwards, preceded by the application of long adhesive strips, and in placing the parts in the best condition for relaxing the affected muscles. Professor Warren, formerly of Baltimore, has suggested, in cases of this kind, the employment of extension by means of adhesive strips, weight and pulley, as seen in fig. 222, from Bryant, upon the same principle as in the treatment of fractures, and has published the results of some cases illustrative of the beneficial effects of his method.   When these means are unavailing, we may, provided the bone remains sound, divide some of the muscles of the stump subcutaneously, and then draw them forward, either with or without incision of the integument, as the case may seem to demand.   If the bone, however, is diseased, the best plan will be to saw it off higher up ; but such an operation is often more hazardous than the original one, and should, therefore, always, if possible, be avoided.

2. SECONDARY AFFECTIONS.

The most common, as well as the most serious, secondary effects of amputation are, as was previously stated, hemorrhage, necrosis, caries, neuralgia, synovial bursæ, varicose enlargement of the arteries, and permanent shortening of the tendons in the vicinity of the stump.

a. Secondary *hemorrhage* is by no means uncommon after amputations, especially in persons exhausted by intemperance, loss of blood, and other debilitating influences, and usually depends either upon the premature detachment of the ligature from ulceration of the arteries, or upon the supervention of gangrene, by which the structures of the stump are softened and disorganized before the vessels are sufficiently occluded by clots and plastic matter.   The bleeding may be sudden and copious, or gradual and slight, though ultimately, if not checked, not the less surely injurious, or even fatal.   It seldom occurs before the tenth or twelfth day, and frequently not until after the third week.   The blood may ooze out at many points, or, if not, in a full stream, either arterial or venous ; more commonly the former.   In the more ordinary cases, the flow may occasionally be promptly arrested by systematic compression, applied directly over the course of the affected artery, immediately above the bleeding orifice ; or, instead of this, the vessel may be included along with some of the surrounding tissues in a ligature.   Now and then the object may be attained by means of an acupressure needle.   When all these attempts fail, the only resource is to cut down upon the main trunk of the artery, some distance above the stump, and to secure it with a ligature, as in the operation for aneurism.

A troublesome form of hemorrhage sometimes accompanies necrosis of the stump, the blood oozing away at each dressing from the gap between the dead and living structures, much to the detriment of the patient and the annoyance of the surgeon.   It evidently depends upon the inability of the vessels in the indurated and diseased parts immediately around the dead bone to retract and occlude their orifices, and generally promptly ceases upon the removal of the sequester, the exciting cause of the hemorrhage.

Fig. 223.

β. Disease of the bone, eventuating in *necrosis*, may be induced in various ways : in general, it is caused by injury inflicted upon it during the operation, consisting either in the laceration and separation of the periosteum, in the excessive jarring of its substance, or in the violence inflicted upon its nutrient artery, thereby cutting off its wonted supply of blood.   Uncovering of the bone, in consequence of too great a brevity of flap, and the accumulation around its extremity of pus, are also very apt to produce it.   Sometimes it perishes from the intensity of the inflammatory action.   The loss of vitality is indicated by the peculiar whitish, greenish, or pale yellowish aspect of the bone, the absence of bloody points upon its surface, and a characteristic hollow noise when struck with the handle of the knife.   The marrow and its envelop generally retain their vitality for a short time after the osseous tissue has died, an event most likely to happen when the bone perishes only in a part of its circumference.   Necrosis, as a result of amputation, is more liable to occur in the thigh-bone than in any other piece of the skeleton,

Necrosis of the Bone after Amputation.

depending probably upon some peculiarity of its organization.   The tibia is also occasionally affected, and a similar occurrence is sometimes met with in the humerus.   The dead bone may come off in the form, first, of an exfoliation, consisting merely of a part

of its outer compact substance; or, secondly, as an osseous ring, with long, narrow, sharp spicules; or, finally, as a complete cylinder or tube, as when it involves several inches of the entire circumference of the bone. The more common appearances of the necrosed bone are exhibited in fig. 223.

The management of these cases must be left very much to the operation of time, especially when the bone has perished high up, and when, in order to reach it, extensive dissection would be required. If, on the other hand, the necrosis is very limited, an attempt may be made to get rid of it with the saw, cutting forceps, trephine, or burr of the surgical engine. Too much caution, however, cannot be used in such an operation, trifling as it appears to be. I have seen death produced by it in two cases, and similar instances have been witnessed by others. It would seem, when a bone is thus affected, as if the system were more than usually intolerant of instrumental interference and loss of blood; the parts are generally excessively irritable, and the constitution rarely fails to sympathize with them in the most lively manner. Besides, the operation is necessarily attended with some degree of hemorrhage, and I am not certain that a patient may not be destroyed in this way alone, especially if he is very feeble and irritable at the time.

Instances occur in which the sequester is firmly, and even obstinately, imprisoned by the remains of the living bone; or, more properly speaking, by the new matter that is thrown out upon its surface, thus occasioning great difficulty in regard to its removal. In a case kindly communicated to me by Professor Markoe, of New York, the sequester, consisting of an inner shell of the femur, was retained for many months by a spur of new osseous substance extending through an opening in its sides, in such a manner as to nail the dead and living parts together, but at the same time allowing the former to be moved freely backwards and forwards upon the latter. It was not until after several attempts had been made at extraction, attended with much pain and constitutional suffering, that riddance was finally effected by means of the chisel and forceps.

γ. *Caries* of the bone, as a consequence of amputation, is by no means uncommon. I have also seen cases where it was obviously due to injury inflicted previously to the operation, as when a bone has been severely jarred by a blow, fall, or a partially spent bullet. In this condition it is not unusual to find the caries conjoined with necrosis, one part of the bone being in a state of ulceration, while another is completely deprived of vitality. When the disease is of long continuance, the areolar and compact tissues have an inflamed, discolored appearance, and their consistence is so much diminished that they may be cut with the knife or crushed with the finger; the periosteum is opaque, thickened, and easily pealed off; and the medullary canal is either completely hollowed out, or occupied by a softened, reddish, pulpy substance, without any trace of marrow and endosteum.

No stump can, of course, be healthy under such a state of disease. The bone keeps up constant irritation; abscess after abscess forms; and the soft parts, incessantly inflamed and swollen, are tender, painful, and intolerant of pressure. The proper remedy is excision of the affected bone, or reamputation, according to the extent of the disease.

δ. A stump is sometimes rendered exceedingly painful and uncomfortable by the development of an *exostosis* upon the extremity of the bone. The new growth generally presents itself in the form of a stalactite, or of an elongated, spur-like projection, narrow, cylindrical, straight, or crooked, from an inch to an inch and a half in length, and of variable thickness. The proper remedy is excision.

ε. Another disagreeable, frequently, indeed, a most distressing effect of this operation, is *neuralgia*, coming on at a variable period after its performance, and often continuing, despite the most judicious and persevering efforts at relief, to molest the patient during the remainder of his life. Supervening generally without any assignable cause, it is most common in nervous, irritable persons, subject to the disease in other parts of the body. Women are more prone to it than men, and in them the attack frequently coincides with the eruption of the menses. Sometimes the disease is periodical, especially in residents in malarial regions, the paroxysms coming and going very much as in intermittent fever. Most commonly, however, the pain is irregular, one portion of the day being as liable to it as another. It is generally of a darting, shooting nature, or dull, heavy, and aching, and is invariably aggravated by damp states of the atmosphere, fatigue, and disorder of the digestive apparatus.

In the more violent forms of this affection the immediate cause of the suffering is a bulbous enlargement of the nerves ramifying through the stump, as in fig. 224. This degeneration takes place, to a greater or less extent, after nearly every amputation, and is, therefore, to be considered as a disease only when it exists in excess. Under such circumstances the tumor, which sometimes attains the size of a hickory-nut, or even of a

pullet's egg, is of a firm, dense consistence, and is composed of a strong fibrous stroma, inlaid with hypertropied and curiously interlaced nervous trunks and filaments. It is, in fact, a true neuroma. The accompanying pain is exquisite, and the part is so sensitive as to be intolerant of the slightest touch ; the general health is much affected, and the patient is remarkably susceptible of atmospheric vicissitudes, every change in the weather from warm to cold and dry to wet being followed by an increase of suffering. The malady is of a much more serious character than the other, and requires proportionately stronger measures. In general, nothing short of removal will avail ; by excision, if the tumor be single and easily accessible, by amputation, if it be multiple and deep-seated. The subcutaneous division of the affected nerves seldom affords even temporary relief, and stretching of the principal nerves of the stump is generally equally futile.

Fig. 224.

Neuromas of a Stump, after Amputation of the Arm A large mass at *a* ; opposite *b* the tumors are more defined.

For the milder varieties of neuralgia the ordinary remedies sometimes suffice, as in neuralgia in other parts of the body, especially quinine ; or, if the patient is anemic, quinine and iron, combined, in either case, with strychnia and arsenious acid, belladonna, stramonium, or aconite ; the effects of the articles being studiously watched, lest an overdose be given, and life placed in jeopardy. Sometimes marked benefit accrues from the exhibition of colchicum and morphia, administered in full doses at bedtime, as one drachm of the wine to half a grain of the salt. These medicines are particularly valuable in subjects with a rheumatic state of the system. Locally, iodine, blisters, issues, and other counterirritants are used, along with anodyne embrocations. Hypodermic injections of atropia and morphia are occasionally serviceable. The stump is well protected from cold, friction, and pressure.

ζ. A remarkable *trembling*—perhaps it might be called a spasm of chorea—of the stump is occasionally met with. I have seen only two cases of this occurrence, both the result of gunshot injury. The affection, in each instance, supervened several months after the amputation, and closely resembled what is called shaking palsy. The muscles were in constant motion except during sleep, when they were perfectly quiescent ; and the stumps were exceedingly susceptible to cold. The general health was good. No mode of treatment that could be devised exercised the slightest influence upon the disease. In one of the cases, the whole of the cicatrice had been cut away without any visible benefit.

η. A *burse* sometimes forms upon the stump, generally immediately over the end of the bone, in consequence of the long-continued pressure of an ill-constructed and ill-adapted artificial leg. The tumor, in time, becomes exquisitely tender and painful, compelling the patient to seek relief. The seat and character of the disease are usually pointed out by the discoloration and swelling of the part, which often fluctuates on pressure. The history of the case, aided by the exploring needle, will readily serve to distinguish it from abscess, the only lesion with which it is likely to be confounded. The proper remedy is excision in the severer grades of the affection, and in the milder a more careful adaptation of the artificial to the natural limb.

θ. Of *fibroid degeneration* of the tissues of the stump a number of cases have come under my observation since the late war, principally in soldiers who had undergone the circular operation with inadequate covering of the bone. In some instances, however, I have also noticed it where there was no such deficiency, from the long-continued pressure of an artificial limb, provoking and keeping up inflammatory irritation. The skin, in these cases, is unusually red, indurated, puckered, tender, exquisitely sensitive, and, here and there, perhaps, even ulcerated. The parts in front of the bones, immediately beneath the skin, are of a dense fibroid consistence, creaking under the knife, of a whitish or grayish color, and composed of a striated matter, interspersed with cells containing nuclei and nucleoli. The only available remedy is excision, conjoined, if there be a deficiency of covering, with removal of a portion of bone. Occasionally reamputation is required.

ι. *Fatty degeneration* of the muscles is always present in old stumps, existing, in greater or less degree, either by itself, or, as is more generally the case, in union with the fibroid transformation. The oily matter gives the altered muscles a peculiar yellowish

appearance, and causes by its pressure more or less atrophy of the fibres, without materially diminishing the size of the stump.

x. *Fracture* of the bone in the stump of an amputated limb is a very uncommon occurrence, and presents nothing peculiar either as it respects its symptoms, its union, or mode of treatment.

λ. Varicose enlargement of the *arteries* of the stump is extremely rare, only a few instances of it being upon record. Unless the disease is unusually extensive, which, however, it is not likely to be, nothing need be done for its relief, as it does not generally act even as an inconvenience.

In a case of this kind, under my care in 1870, in a colored man, twenty-four years of age, the enlargement began nearly six years previously in consequence of amputation of the lower third of the thigh performed on account of a gunshot injury of the knee. The stump was exceedingly conical, and a source of so much suffering as to render it almost impossible to wear an artificial limb beyond a few hours at a time. The femoral and saphenous veins were excessively enlarged and varicose, especially towards the lower part of the stump, where they formed a mass fully the size of an ordinary fist, throbbing and pulsating violently, and emitting the peculiar whirring sound so characteristic of aneurismal varix. As the pulsation could readily be controlled by pressure upon the femoral artery, I cut down upon that vessel at Porter's space, a few lines below Poupart's ligament, and applied a temporary ligature, hoping to effect occlusion: owing, however, to the diseased condition of the artery, and probably also of the blood, ulceration took place at the site of the ligature, followed, on the sixth day, by copious and exhausting hemorrhage, terminating fatally three days afterwards.

Mr. Cadge, of Norwich, has given the particulars of a remarkable case of aneurismal varix found in a stump, after amputation of the ankle-joint. The tumor, situated just above the internal malleolus, immediately beneath the skin, was elastic, pulsatile, two inches in length, and the seat of a peculiar thrill, so characteristic of this class of affections. Compression of the posterior tibial artery readily arrested its pulsation. The annexed sketch, fig. 225, from Erichsen, affords a good illustration of this extremely rare occurrence.

Fig. 225.

Aneurismal Varix in a Stump.

A case of aneurism of the brachial artery formed after amputation of the lower portion of the arm, from injury inflicted by the knife during the operation, has been reported by G. W. Smith, of Plainfield, Pennsylvania. The tumor, upwards of six lines in diameter, was situated about two inches and a half above the point of ligation of the artery, and consisted exclusively of the internal and middle tunics, the outer one encircling it in the form of a well-defined ring. As the stump was not sound in other respects, reamputation was performed. In an instance related by Warner in his "Cases of Surgery," an aneurism formed three times on this vessel after amputation of the arm. For the cure of two of the tumors the artery was tied immediately above the seat of the disease; but for the last, he applied his ligature high up near the axilla, on the principle of the Hunterian operation, and there was no further trouble. In a case reported by Delacour an aneurism formed on the anterior tibial artery after amputation for a compound fracture of the leg; repeated hemorrhages occurred, and life was saved only by ligation of the femoral artery. In all the cases an unsound condition of the coats of the affected vessel was unquestionably the cause of the aneurism.

μ. Permanent shortening of the *tendons* in the immediate vicinity of the stump is sometimes a source of great discomfort, as well as of serious interference with the usefulness of the limb. The accident is most liable to happen in the tendons of the hamstring muscles after amputation of the leg, and in the tendo Achillis after removal of the foot by Chopart's method. Much may be done, in both cases, in the way of prevention, by attention to position during the after-treatment: it is, in fact, the neglect of this precaution that usually occasions the difficulty. When the occurrence is unavoidable, or is already fully established when first brought under the notice of the surgeon, rectification is attempted, generally with a fair prospect of success, by the subcutaneous section of the shortened tendons, and the subsequent use of an extending apparatus, constructed on the

principle of the double inclined plane, with such modifications as may be required to adapt it to each particular case.

ν. The surface of an old stump occasionally suffers from *eczema*, coming on, perhaps, long after the amputation. The occurrence, which is most common in an imperfectly healed stump, is characterized by the formation of little blebs and chaps, cracks or fissures, the seat of a thin, pale, watery discharge, and of more or less itching. The most suitable remedies are cleanliness, conjoined with an occasional laxative, and the application of zinc ointment, dilute tincture of iodine, and solutions of acetate of lead. Occasionally nothing allays the itching so promptly and effectually as the use of cosmoline with the addition to the ounce of ten grains each of camphor and chloral. In obstinate cases gentle ptyalism may be required.

ξ. *Ulceration* of the stump from insufficiency of skin, violent inflammation of a diseased cicatrice, and other causes, is one of the most distressing of the secondary effects of amputations, keeping the parts tender and painful, and interfering with the use of an artificial limb. In the milder cases relief is afforded by the application of nitrate of silver, lotions of acid nitrate of mercury, and various kinds of unguents, along with leeches and scarifications. Occasionally great benefit is experienced from thorough vesication with cantharidal collodion. In obstinate cases I have sometimes been obliged to excise the ulcer, especially when it depended upon the presence of a badly healed cicatrice. When the bone is in a diseased, softened, or carious condition, the affected part must be removed at the same time, otherwise the operation will be of no avail.

Filling up the gap left by the removal of the ulcer with sound skin taken from the neighboring parts is sometimes advisable, although the operation is one necessarily attended with occasional failure. Indeed, such a result will almost be inevitable unless the bones are perfectly healthy, and the transplanted flap is very thick and large, properly secured in its new place, and well protected during the after-treatment. Skin-grafting, properly so-called, may occasionally prove serviceable under such circumstances.

Resection of the stump may be required when the bone is uncovered, or imperfectly protected by soft structures. The operation is easily executed, care being taken to keep the knife as closely as possible in contact with the bone during the necessary dissection, so as not to interfere with any important vessels and nerves. A similar proceeding may be required in case of caries, necrosis, or exostosis.

Reamputation will be necessary when the stump is so conical as to unfit it for the use of an artificial limb; when the soft parts are seriously diseased; when the bones are extensively thickened, necrosed, or carious; and, finally, as already stated, when the stump is the seat of incurable neuralgia. It is barely possible that an aneurism of the stump might also necessitate such a resort. The operation is performed upon the same general principles as the primary one, either in the continuity of the stump or at the nearest joint, as circumstances may demand. The result, of course, is not always favorable, especially when reamputation is performed near the trunk for the relief of a stump of the lower extremity.

ο. *Malignant* disease of the stump, in its primary form, is uncommon, but sufficiently frequent as a secondary occurrence. Primary carcinoma usually appears in the form of epithelioma, as the result of protracted irritation from the pressure of the artificial substitute, and pursues the same course as in other parts of the body. Secondary carcinoma may take place either upon the cicatrice of the stump or in the skin and connective tissue, the period of its occurrence varying, on an average, from six weeks to three months from the time of the amputation. The treatment, in favorable cases, is by excision or amputation; under opposite circumstances, by palliation.

SECT. VI.—CONSTITUTIONAL EFFECTS OF AMPUTATIONS.

The most common constitutional occurrences after amputations, especially of the larger limbs, are excessive prostration, traumatic fever, pyemia, congestion of the lungs, tetanus, retention of urine, and, as a secondary consequence, hectic irritation.

α. The *shock*, consequent upon amputation, is frequently extremely severe, and may be due, either partly or exclusively, to mere depression of the nervous system, caused by the extent, violence, and duration of the operation, to loss of blood, or to the effects of anæsthetic agents, or to all these circumstances combined. More or less nervous depression will almost necessarily occur during such an operation, however slight, but it generally passes off without any particular treatment, simply under the influence of repose, exposure to the air, and a drink of cold water. In the more severe forms of the affection,

however, it may endanger life by its long continuance or excess, and then demands prompt attention. The most appropriate remedies are, lowering of the head, so as to facilitate the flow of blood to the brain ; the administration of brandy and ammonia, and tincture of digitalis, by the mouth, if the patient can swallow, or by the rectum, or under the skin, if the power of deglutition is lost ; a full dose of morphia and atropia ; and sinapisms to the spine, extremities, and precordial region.

β. *Traumatic fever* generally sets in within from six to twelve hours after the operation, and will be violent or otherwise according to circumstances, of which the most important are, the extent of the previous shock and loss of blood, and the temperament, habits, and state of health of the patient. It is characterized by heat and dryness of the skin, flushed countenance, suffusion of the eyes, headache, restlessness, excessive thirst, rapid respiration, and a frequent, hard, and irritable state of the pulse, attended, when there has been much hemorrhage, by a peculiar jarring impulse. These symptoms, in the milder cases, will often speedily subside spontaneously, but under opposite circumstances they will require attention, and, if the surgeon is not fully on his guard, he will be very apt to do a great deal more than is either necessary or proper. The fact is, this is not unfrequently the critical point in such cases ; if we do too much, the patient is irretrievably gone, the consequence being death either from exhaustion, pyemia, erysipelas, or a low state of fever, which nothing can cure. Hence the greatest caution is to be observed ; the symptoms must be watched, and the utmost care must be taken that they do not deceive us by their violence, which is often feigned rather than real, and, therefore, extremely apt to entrap the unwary and inexperienced. In general, it will suffice to administer a mild aperient, as a little Rochelle salt, a Seidlitz powder, or citrate of magnesium, to sponge the surface frequently with tepid water, and to give cooling, acidulated drinks, which are always very grateful in such cases. If the fever threatens to be obstinate, a little antimony is prescribed, either alone or in union with morphia, to promote perspiration, allay the heart's action, and induce sleep. The lancet is scrupulously withheld, unless the symptoms are of extraordinary urgency, and the patient is very plethoric, without having been weakened by shock or loss of blood. Then a vein in the arm may be opened, and the effect of the stream carefully watched, the bleeding being arrested as soon as the pulse evinces signs of flagging.

Very often after amputations of the larger limbs, especially those performed for compound fractures and dislocations, gunshot wounds, and railway accidents, a low form of fever ensues, the system reacting badly, the countenance looking pale and haggard, the skin being icterode, cold, and doughy, and the pulse shattered, with great depression of spirits, and an utter indifference on the part of the patient as to his fate. It is difficult to say what the real condition of the system under such circumstances is, but the probability is that the disorder is mainly due to the loss of blood and nervous fluid consequent upon the excessive shock to the system at the time of the accident, heightened, perhaps, by the effects of the operation. However this may be, the system being depressed and withered, the issue is usually most disastrous, very few persons recovering, no matter what course may be adopted for their relief. The chief reliance must obviously be upon stimulants, as brandy, quinine, ammonia, and nutritious food, with opium to allay pain and procure sleep.

γ. Amputations, especially those of the thigh, are often followed by *retention of urine*, caused apparently, not by any actual paralysis of the bladder, but by a want of proper volition, the organ retaining its power, without the patient being able to call it into action. It usually supervenes within the first twenty-four hours after the operation, and seldom lasts less than two or three days, when it gradually passes off. From what I have seen of this affection, in this class of cases, I am not disposed to ascribe to it, as some have done, an inflammatory origin : that such a condition occasionally exists, is certain, but, in general, I am sure it does not. Knowing how frequent retention of urine is after this and other capital operations, the attendant should diligently watch for it, and promptly use the catheter, in the event of its occurrence.

δ. A not unfrequent event after amputation is *pyemia*. Experience shows that it is most to be dreaded in cases preceded by extensive shock to the system ; hence it is very common after gunshot, railway, and steamboat accidents, attended with extensive laceration of the soft parts, and after compound fractures and dislocations. Professor Ashhurst finds that of 3110 cases of amputation collected from the records of several hospitals, pyemia occasioned death in 30.1 per cent. of all the fatal cases, and in 9 per cent. of the entire number. The attack generally comes on within the first six or seven days, being ushered in by violent rigors alternating with flushes of heat, and followed by a bad state of the

stump, with aching pains in the limbs and joints, excessive thirst, restlessness, and a tendency to delirium even early in the disease. When the joints are involved, there is commonly an erysipelatous blush upon the overlying skin, with great tenderness on pressure and exquisite pain on motion. The case generally proves fatal in less than a week from its commencement, and examination after death usually reveals the existence of small and ill-defined abscesses in some of the internal organs, particularly in the lungs, liver, and spleen.

The treatment is by stimulants and tonics, such as brandy and milk, quinine, and opium, given in large quantity to support the rapidly sinking powers of nature. Mercury, in the form of calomel, is sometimes useful, and may be administered in doses of three grains every four, six, or eight hours, with a view to rapid but gentle ptyalism. The bowels are moved by enemas, all active purgation being inadmissible. Locally, the ordinary remedies are employed, generally only such as are of a soothing character.

ε. *Congestion of the lungs*, if not actual inflammation of these organs, is another effect of this operation, occurring either alone, or conjointly with pyemia, erysipelas, or an adynamic state of the system. It generally comes on in a slow and insidious manner, and is, therefore, liable to make serious, if not fatal, inroads before its true nature is suspected, none of the characteristic signs of pneumonia being present. The only way in which it is usually detected is by auscultation and percussion, or by the changes perceptible in the respiratory movements and sounds of the chest. These changes are generally most conspicuous in the lower and posterior portions of the lungs, where the greatest amount of blood, in debilitated states of the system, is, in obedience to the laws of gravity, most liable to accumulate, and, consequently, to produce the greatest degree of mischief. In most of the cases of pulmonary congestion that I have met with after amputation of the larger limbs, there was either an entire absence of pain and cough, or these symptoms were so trivial as, in themselves, to attract hardly any attention. The patient is able to lie upon his back or on either side, and it is not often that the respiration is materially hurried or embarrassed.

Dry cupping, rubefacients, and blisters are the most reliable local remedies, the system being supported with stimulants and tonics, aided by morphia and minute doses of tartrate of antimony and potassium. The prognosis is generally unfavorable, especially if the disease has made considerable progress and the patient is much exhausted.

ζ. The occurrence of *tetanus* after amputation is uncommon, especially in the more temperate regions of this and other countries. Mr. Curling, in his work on this disease, gives a table of 128 cases of traumatic tetanus, three of which only were caused by amputation. The affection is much more frequent in military than in civil practice, and is most liable to be produced in persons of a nervous, irritable temperament, in consequence of exposure to direct currents of cold air. A few years ago I lost a man on the third day after an amputation of the thigh, solely from this cause; he had been moved, during my absence from the hospital, to an open door, so as to allow the air to blow upon him in a full stream. I have known other cases that were induced in similar manner; and I refer to the fact in order to attract special attention to it. The treatment of this disease being discussed elsewhere, it is unnecessary to refer to it here.

η. *Hectic irritation* is observed only, or chiefly, as a secondary effect of amputation, being caused either by profuse suppuration, or by a poisoned state of the blood and solids, from shock, hemorrhage, or the absorption of pus. The symptoms are characteristic, and the treatment consists of such means as are calculated to sustain the flagging powers of the system, especially quinine and iron, with aromatic sulphuric acid, atropia, milk punch, and nutritious food.

SECT. VII.—ARTIFICIAL LIMBS.

The stump, after the cicatrization of the wound, gradually undergoes, as might be expected, important changes in its several structures, so as to adapt it the better for the various hardships which it is destined to experience in the daily routine of a business life, and especially for the support of an artificial limb. The muscles, deprived of the power of motion, soon become pale and wasted, and are eventually transformed into hard, dense, fibrous bands, entirely destitute of their primitive properties. The bloodvessels are obliterated as high up as their first large collateral branches, and converted into solid, rigid cords; the extremities of the nerves are expanded into bulbous masses, of an elongated, cylindrical shape, exhibiting more of a nervous than of a fibrous structure; and the ends of the bones are rounded off, and covered in by a thin shell of osseous

matter, which thus effectually closes the medullary canal, as seen in fig. 226. The subcutaneous fat gradually disappears, and the skin, unless habitually subjected to pressure, is rendered abnormally thin and sensitive. These changes are, of course, the work of time, and hence they are always more conspicuous in proportion to the age of the stump. In the forearm and leg, the ends of the two bones are always united, when the cure is perfected by a kind of osseous bridge.

Fig. 226.

Appearance of the Bony Stump after Amputation.

The period at which the stump may be in a condition for the reception and support of an artificial limb must necessarily vary according to circumstances; if the operation has been well done, and the cicatrization has gone on favorably, the substitute may be used as early as the sixth or eighth week, although in general it will be better to wait some time longer, inasmuch as too early a recourse to it will be likely to render the parts sore and sensitive, if not the seat of ulceration and severe pain. So much, indeed, is the patient's comfort influenced by attention to this point, that it is hardly possible to be too cautious respecting it. The stump should be tightly bandaged for several weeks previous to the application of the artificial limb, to promote the absorption of redundant material, and thus impart to it somewhat of a conical shape. Washing it well several times a day with a strong solution of tannic acid and alum will have the effect of hardening the integument, so as to moderate its sensibility and prevent excoriation.

Great improvement has been effected in modern times in the construction and adaptation of artificial limbs, and there is reason to believe that the inconvenience and suffering occasioned by their use are more frequently attributable to the misconduct of the surgeon than to the want of skill on the part of the manufacturer of the substitute. It has only been within a comparatively recent period that operators have hit upon the correct principles of making good and serviceable stumps. Allanson, upwards of three-quarters of a century ago, understood the subject much better than it has been understood since, if we except the last twenty-five or thirty years. He strongly insisted upon a long and well-shaped stump, and exerted himself with great ability, but in vain, to induce the profession generally to follow his example. The happy changes lately introduced into this department of operative surgery are, I believe, mainly due to the manufacturers of artificial limbs, who, with an ingenuity and perseverance worthy of so good a cause, have reduced the whole process to one of principles founded upon the study of anatomy and mechanical philosophy. It would be difficult to conceive of any apparatus more beautiful it its construction, or more admirably adapted to the end proposed, than the artificial substitutes manufactured in this country. Combining lightness with strength, and neatness with symmetry, they are worn with great comfort and satisfaction, and are apparently as perfect as any piece of mechanism of the kind can well be made. The joints, constructed on the principle of the ball and socket articulation, are situated at the proper points, and their surfaces move upon each other with great accuracy and facility, through the intervention of cords, wires, springs, and levers, the whole arrangement being a close imitation of the natural muscles and tendons, if not in shape, at least in position and function. The socket is made with special care, neatly fitting the stump in every portion of its extent, and is well padded to prevent friction and excoriation, the pressure being diffused over the entire circumference of the stump, while the extremity of the latter is perfectly free in the interior of the former. The annexed cut, fig. 227, affords a good illustration of this apparatus.

Fig. 227.

To enable the patient to wear his artificial limb with comfort and convenience, it is necessary that he should have a good, long stump, well covered, perfectly even, and of proper shape, being neither too square and fleshy on the one hand, nor too thin and conical on the other. A short, thick, ill-formed stump is a great evil, from which the patient can promise himself no good; on the contrary, it can hardly fail

to be a constant source of annoyance and pain, becoming sore and excoriated under the slightest exercise. The duty of the surgeon, therefore, is one of great responsibility, and cannot be discharged without properly weighing, in every instance, the probable consequences of the operation. When he has his choice, his invariable aim should be to make a long stump, so as to afford an abundant leverage and support for the artificial contrivance. In the leg and thigh its length should not, if possible, be less than nine or ten inches; hence the place of election, for the former, should be only about from three inches to three inches and a half above the ankle, and for the latter about the same distance above the knee. It is not always, however, by any means, in the power of the surgeon to select the point where he might otherwise cut off the limb, and he must then be contented in leaving as much substance as he can. If the leg is amputated very high up, the weight of the body may be supported upon the knee, especially if the patient's social position is such as to prevent him from wearing an expensive substitute, and this will be the more necessary because it is often very difficult, if not impossible, to preserve the straightness and flexibility of the joint in the event of a very short stump, on account of its incessant tendency to retraction and ankylosis. It is for this reason that some surgeons have advised amputation of the thigh just above the knee, when accident or disease interferes with the formation of a suitable stump below; but, if we consider the difference in the danger of the two operations, we should hesitate before we give our sanction to such counsel, not forgetting that the risk increases with every inch the nearer the knife approaches the trunk. In amputation of the thigh, the principal pressure of the artificial limb upon the stump is concentrated near the body, but care is taken not to apply any direct pressure to the perineum, lest it should produce excoriation.

After amputation at the hip-joint an artificial limb can only be worn with the aid of a gutta-percha stump, about ten inches in length, firmly secured around the pelvis by a broad, well-lined girdle. With such a contrivance very little difficulty is experienced in walking.

In amputations in children, the development of the limb is always partially arrested, so that, by the time the individual attains his full stature, it will be several inches shorter, as well as thinner, than its fellow of the opposite side. Now, surgeons in applying this knowledge to amputations of the inferior extremity, have advised that it should never be cut off below the knee, but at the lower third of the thigh, on the ground that, if this precaution be neglected, one knee will ultimately be elevated a considerable distance above the other, thereby imparting to the gait a peculiar grotesque appearance. Experience, however, has shown that amputation of the leg, even if the stump is only a few inches in length, instead of being an objection, is a decided advantage, the limb thus affording a much longer leverage than when it is cut off through the thigh, for the adaptation of the arti-

Fig. 228.

Fig. 229.

ficial substitute, the knee-joint of which can always be made to correspond, in situation, with that of the sound limb. Moreover, by adopting this procedure, the weight of the body, provided the stump is not too long, is supported upon the knee; another most important desideratum under such circumstances.

Dr. Bly, of Rochester, has devised an artificial limb, which, in addition to the ordinary qualities of such a contrivance, admits of lateral motion at the ankle, in imitation of the

natural joint, and is, in all respects, constructed upon strictly anatomical principles. The artificial leg of Dr. Byrd, of Baltimore, has the advantage of affording perfect ventilation to the inclosed stump, thus keeping it constantly at an even temperature through the process of insensible evaporation from the surface.

The annexed drawing, fig. 228, conveys a good idea of the artificial limb usually worn by the laboring classes after the loss of a leg or thigh. It may be made very light, and, if the stump be of proper length, affords an admirable substitute, the person being able to walk nearly with the same facility as in the natural state.

Various attempts have been made to construct artificial hands and arms, and there are now a great many of these contrivances in the shops, which, in point of neatness and adaptability, leave hardly anything to be desired upon the subject. Fig. 229 affords an illustration of such a limb.

SECT. VIII.—MORTALITY AFTER AMPUTATIONS.

The mortality from amputations is so much influenced by extraneous and intrinsic circumstances, and requires such a vast amount of statistical material for comparison and contrast, that it is extremely difficult, if not impossible, in the existing state of the science, to arrive at any satisfactory conclusions respecting it. It has long been known that the danger of the operation is always greater in proportion to its proximity to the trunk and the size of the limb. Hence, amputation of the leg is less hazardous than amputation of the thigh, and of the thigh in its continuity than of the thigh at the hip-joint. The mortality of the operation is also greater, as a general rule, in hospital than in private practice, in military than in civil practice, and in private practice in cities than in the country. Amputations on account of railway accidents are extremely dangerous, and are liable to be followed by the worst consequences, even in subjects perfectly healthy at the time of the accident, owing to the excessive tendency to mortification and pyemia.

The circumstances which mainly influence the mortality after amputation may conveniently be arranged into four classes, the first of which refers to the age, previous health, and social position of the patient; the second, to the causes necessitating the operation; the third, to the nature, seat, and extent of the operation; and the last, to the after treatment.

1. It will readily be granted that the condition of the *patient* at the time of the accident rendering amputation necessary must exert an important influence upon his fate. If he is old, broken in constitution, or in a state of poverty, so as to preclude the possibility of receiving proper attention after the operation has been performed, the chances are that he will die, either from shock, erysipelas, pyemia, or congestion of the lungs. The previous state of his health exerts no little influence upon the recovery; not, perhaps, however, to the extent that is generally imagined. A person who is in bad health at the time he is severely injured cannot be expected to bear the shock of an amputation with the same impunity as one whose health is good. The system, exhausted by previous suffering, is ill qualified in such a case to react favorably after the nervous depression consequent upon the operation.

Age also exerts considerable influence over recovery. Children generally bear amputation better than adults and elderly persons, being less subject to attacks of erysipelas and pyemia, and making a more rapid recovery. The parts, too, unite more frequently by the first intention. At the Hôpital des Enfants in Paris, Guersant, who annually performs from fifteen to twenty operations of this kind, including all the larger limbs, and also occasionally the hip and shoulder-joints, loses not more than one out of about nine cases, although nearly all are of a scrofulous character. He ascribes his extraordinary success mainly to two circumstances; first, a thorough preparation of the system, and, secondly, the use of an abundance of good, wholesome, and nutritious food immediately after the operation, on the well-known principle that children do not tolerate abstinence nearly so well as adults.

Notwithstanding the success of Guersant at the above institution, it is a well-known fact, a fact amply attested by the experience of surgeons in all parts of the world, that scrofulous children are usually bad subjects for amputation as it respects their ultimate fate. Many of them do well for some time after the operation, especially if they are properly fed and cared for; the wound often heals with surprising rapidity, and, for a time, everything looks uncommonly promising. By and by, however, perhaps at a comparatively early period, the wound breaks out afresh, the neighboring bones or joints become involved, the general health gives way, and the patient finally perishes of pulmo-

nary phthisis, meningitis, albuminuria, dropsy, general œdema, fatty degeneration of the liver, or some other disorder denotive of a vitiated and depraved state of the constitution.

Advanced age is eminently unfavorable to a good result, experience having shown that amputations in old persons, especially amputations of the lower extremities, almost invariably terminate disastrously.

The social position, or the habits and occupation of the patient, must materially influence the result of an amputation. The poor man cannot command the same care and attention as the rich; he often suffers for want of proper food and nursing, and even medicine, at a time, perhaps, when he is most in need of them, and there is no doubt that many patients perish from this cause alone that might otherwise be saved. Intemperance in eating and drinking, and unwholesome occupations, must necessarily produce a prejudicial effect upon the result.

2. The influence of the *causes* necessitating amputation has long been a subject of remark on the part of practitioners, both in private and public. Thus, it is an established fact that a person who undergoes amputation of one of the larger limbs on account of a severe injury, as a compound fracture, or a lacerated and contused wound, is much more likely to perish from its effects than one who loses a limb on account of chronic disease. The system, in the former case, deeply depressed by the shock of the accident, often reacts very slowly and imperfectly, and is, therefore, ill prepared for the approaching ordeal of another violent commotion, the effect of which is felt by every organ and tissue of the body. In disease, on the contrary, the constitution, although perhaps extensively implicated, has become inured to suffering, and, unless too much prostrated, will generally be immensely benefited by the removal of the offending parts. The chief exception to this rule is in malignant affections, in which, in consequence of the vitiated state of the solids and fluids, amputation is often followed, and that very rapidly, by the worst results.

3. In considering the probable result of a case of amputation, we must not forget to take into view the nature, seat, and extent of the *operation*. Experience has proved that, in civil practice, primary amputation is, other things being equal, a decidedly more dangerous procedure than secondary. The very fact that such an operation is required shows that the accident for which it is performed must have been a severe one, involving, perhaps, the most dreadful lesion of the bones, muscles, joints, and bloodvessels, with frightful depression of the nervous system. Now, it is surely impossible that a patient thus circumstanced should be in a favorable condition to submit to another violent shock, such as must necessarily attend the removal of the affected limb, within a short time after reaction has been established. The statistics, both of private and hospital practice, in America and Europe, are decisive upon this subject, proving, beyond the possibility of doubt, a greater mortality after primary than secondary amputations. Thus, of 456 primary amputations of the thigh, leg, and arm, performed in four American hospitals, 157, or 34.21 per cent., terminated fatally, while in 174 secondary ones the number of deaths was 73, or in the ratio of 41.95 per cent.

In military practice, on the contrary, the results of amputations are reversed, the primary being incomparably more favorable than the secondary. This has been the result of the experience of surgeons in all ages and in all countries since the invention of gunpowder. Larrey and Guthrie saved three-fourths of their cases after primary operations, and the returns of the British surgeons in the Crimea are of a similar character, although the rate of mortality here was considerably higher, owing to the fact that most of the wounds were inflicted with the conical ball; whereas in the campaigns of Bonaparte, and in the Peninsular war, they were made with the round ball, the effects of which are, as a general rule, much less destructive than those of the former. The observations of European surgeons in regard to the superiority of primary over secondary amputations were abundantly verified during our late war, on both sides of the line.

The differences between the results of primary and secondary amputations in civil and military practice are no doubt due to the circumstances under which they are performed and the causes which lead to their necessity. In the first place, there is generally less shock in injuries received on the field of battle than in those received in civil life. Secondly, the soldier usually submits to the removal of his limb with greater sang-froid than the civilian, and often glories in his loss, believing that the world will regard it as an evidence of his prowess and patriotism; whereas the latter finds in his misfortune nothing but regret and private calamity. Thirdly, the operation is commonly more promptly performed in military than in civil practice, delay, in the latter case, being frequently occasioned by the doubts of the surgeon and the interference of the patient and of his

friends ; and, lastly, a soldier has not much chance of recovery from an amputation, when, an attempt being made to save his limb, he is subjected to rough and tedious transportation, and is afterwards obliged, when the operation has been performed, to breathe the contaminated atmosphere of a crowded hospital, tenanted by persons borne down by similar accidents. Under such circumstances, the mortality from erysipelas, pyemia, and typhoid fever will, other things being equal, be much greater than in private practice. Faure, from these and other causes, lost 270 out of 300 secondary amputations consequent upon injuries received in battle.

The size and situation of the wound exert an important influence upon the recovery. Here again the statistics furnished by various authorities are most eloquent and decisive. They have conclusively established the fact, now regarded as a great general law, that the larger the wound is, and the nearer it is to the trunk, the greater is the danger to life. Thus, Malgaigne, in his statistics of amputations of all kinds in the hospitals of Paris, found that the mortality after the removal of the great toe was in the ratio of one to six, whereas that of one of the smaller toes was only as one to twenty-six. In amputations of the foot the proportion of deaths was about twenty-five per cent., of the leg fifty-six per cent., and of the thigh sixty-two per cent. These results have been abundantly verified by the statistics of other institutions, as well as by those of military and private experience, and they are full of interest as establishing a law, which should never, if possible, be violated.

The causes which induce this difference in the larger and smaller amputations are chiefly shock, hemorrhage, pulmonary congestion, septicemia, pyemia, erysipelas, profuse suppuration, and gangrene of the stump. Tetanus, too, is more frequent after the former than the latter, although the mortality from this affection is not great under any circumstances, especially in the more temperate regions of this and other countries. It is certainly not difficult to understand the reason why the removal of a large limb should be attended with so much more risk than that of a small one. In the former case, the patient has to contend not only with the shock of the accident necessitating amputation, which is often of itself almost sufficient to destroy him, but as soon as reaction is established he is subjected to another source of depression, perhaps almost equally great, from the operation, frequently involving copious hemorrhage, and liable to be followed by profuse suppuration and high febrile excitement, all tending to depress and exhaust the vital powers. In the latter, on the contrary, there is little or no shock, either from the accident or the operation ; the loss of blood is inconsiderable ; and the inflammatory effects, local and constitutional, are comparatively trivial. In short, there is no disorganization of the blood as there is in the former, and hence no predisposition to pyemia, or purulent infection, and pulmonary congestion, which are a source of so much mortality after the large amputations performed for severe injuries.

The result of an amputation may be materially affected by the situation at which the bone is divided. Experience has shown that, in the femur, tibia, and humerus, more particularly, the danger is much greater when the bone is sawed through its shaft than when it is cut off at its articular extremity, owing to the injury inflicted upon the endosteum, and the consequent liability of this membrane to diffuse suppuration, phlebitis, and erysipelas, followed, not unfrequently, by pyemia in its worst form.

4. Finally, it needs no labored argument to prove that the mortality from amputation must be materially affected by the nature of the *after-treatment*. That many persons perish after such an operation from sheer neglect, bad nursing, or bad surgical management, is a fact too well known to require comment. This is true both of private and of hospital practice, but the remark applies with increased force when it is made with reference to military practice, which, however well the surgical staff of an army may be organized, must often, from the very necessity of the circumstances in which the operations are performed, and the difficulty of conducting the after-treatment in a proper and satisfactory manner, be followed by the most disastrous results, many lives being lost that might, under more auspicious circumstances as to locality, comfort, and convenience, be saved. The state of the atmosphere, as it respects purity and temperature, the prevalence of epidemic diseases, mental depression, want of proper diet, severe depletion, and inattention to the dressings, all exert a more or less powerful influence upon the issue of such an operation. The crowded wards of hospitals in large cities, incessantly pervaded by foul air, are notoriously prejudicial to recovery after amputations ; gangrene, exhausting suppuration, erysipelas, and pyemia are the common lot of such patients, and the consequence is that many of them perish. Hence it is that private practice, especially that of the country, always shows a much more favorable result than that of large public

institutions, or that of large towns and cities. During epidemic diseases, the percentage of deaths from amputations always exhibits a great increase; for it is then that patients are particularly prone to erysipelas, pyemia, and congestive pneumonia. Starvation and depletion are a serious source of mortality after this operation, establishing, as they do, a tendency to purulent infection and to a typhoid state of the system, from which often no stimulants, however powerful and well directed, can afterwards rouse it. I regard such treatment after amputation of a large limb, as, indeed, after every other capital operation, as a great evil, and one which, in my judgment, demands thorough reform on the part of our civil and military practitioners. Finally, I may mention, as another source of mortality, want of attention to the dressings, which, if allowed to remain on too long, not only taint the surrounding atmosphere, but favor the absorption of pus, much to the detriment both of the part and system.

Statistics.—I subjoin the following summary of the statistics of amputations performed at the Pennsylvania, New York City, Massachusetts General, and Boston City Hospitals, because it seems to place the whole subject of the mortality after these operations in a clear and satisfactory light. The table was constructed by Dr. James R. Chadwick, of Boston, and embraces the results of 1370 cases, of which 384, or 28 per cent., proved fatal.

	PRIMARY TRAUMATIC.				SECONDARY TRAUMATIC.				PATHOLOGICAL.			
	Recovered.	Died.	Total.	Ratio of mortality.	Recovered.	Died.	Total.	Ratio of mortality.	Recovered.	Died.	Total.	Ratio of mortality.
Shoulder-joint	21	20	41	48.78	3	3	6	50	11	4	15	26.66
Arm	106	16	122	13.11	17	12	29	41.37	38	6	44	13.63
Forearm	117	14	131	10.68	21	7	28	25	38	8	46	17.39
Hip-joint	...	5	5	100	...	...	...	...	2	0	2	0
Thigh	58	62	120	51.66	24	24	48	50	183	53	236	22.03
Knee-joint	2	3	5	60.00	...	...	...	...	7	4	11	36.36
Leg	135	79	214	36.91	60	37	97	38.14	143	27	170	15.88
	439	199	638	31.03	125	83	208	39.90	422	102	524	19.46

The most extended statistical tables of amputations, both primary and secondary, that have yet been furnished, are those of Mr. James R. Lane, of London. They embrace an aggregate of 5722 cases, derived from various sources, civil and military, private and hospital, European and American, and may, therefore, be regarded as exhibiting a very fair view of the mortality after these operations in different parts of the world.

TABLE 1.—*Amputations for Disease and Injury.*

	TOTAL NUMBER.			DISEASE.			INJURY.			PRIMARY.			SECONDARY.		
	Number of cases.	Fatal.	Mortality per cent.	Number of cases.	Fatal.	Mortality per cent.	Number of cases.	Fatal.	Mortality per cent.	Number of cases.	Fatal.	Mortality per cent.	Number of cases.	Fatal.	Mortality per cent.
Forearm .	370	40	10.81	78	10	12.82	292	30	10.27	232	16	6.89	47	10	21.27
Arm . . .	628	178	28.34	165	44	26.66	463	134	28.94	336	94	27.97	114	37	32.45
Shoulder .	131	51	38.93	18	5	27.77	113	46	40.7	73	25	34.24	26	15	57.69
Leg . . .	1120	384	34.28	471	127	26.96	649	257	39.59	447	172	38.47	175	73	41.71
Knee . .	60	21	35.	...	...	....	...	...	....	...	...	....	...	...	....
Thigh . .	1346	560	41.60	705	192	27.23	641	368	57.41	382	233	60.83	235	124	52.76
	3655	1254		1437	378		2158	835		1471	540		592	259	

TABLE 2.—*Amputations for Injury in Civil and Hospital Practice.*

		Total Number.			Primary.			Secondary.		
		Number of cases.	Fatal.	Mortality per cent.	Number of cases.	Fatal.	Mortality per cent.	Number of cases.	Fatal.	Mortality per cent.
Forearm	Military	105	11	10.47	79	4	5.06	26	7	26.92
	Civil .	174	15	8.62	153	12	7.84	21	3	14.28
Arm . .	Military	203	54	26.65	137	36	26.27	66	18	27.27
	Civil .	247	77	31.17	199	58	29.14	43	19	39.58
Shoulder	Military	67	21	31.33	48	10	20.13	19	11	57.89
	Civil .	32	19	59.37	25	15	60	7	4	57.14
Leg . . .	Military	211	65	30.80	141	41	29.14	71	24	33.80
	Civil .	410	180	43.90	306	131	42.81	104	49	47.11
Thigh . .	Military	357	195	54.62	219	122	55.7	138	73	52. 9
	Civil .	261	162	62.06	164	111	67.68	97	51	52.57
		2067	819		1451	540		587	259	

In the American Journal of the Medical Sciences for October, 1867, Dr. S. W. Gross published the statistics of 13,514 amputations for gunshot injuries, and since that date he has materially added to the number, as will be seen from the subjoined table, comprising an aggregate of 20,933 cases, derived principally from the late military hospitals of the United States, the Austrio-Prussian campaign of 1866, and the wars in the Crimea, Schleswig-Holstein, and Italy.

Amputations for Gunshot Injuries.

Amputations of the Superior Extremity.	Total.	Recovered.	Died.	Percentage of deaths.
Wrist-joint .	176	125	51	28.97
Forearm .	2462	1954	508	20.62
Elbow-joint .	93	65	28	30.10
Arm . . .	7292	5258	2034	27.89
Shoulder-joint .	1392	883	509	36.56
	11,415	8285	3130	27.42
Amputations of the Inferior Extremity.				
Ankle-joint .	148	112	36	24.32
Leg . . .	4011	2645	1366	34.05
Knee-joint .	246	74	172	69.1
Thigh .	4876	1349	3527	72.53
Hip-joint .	237	30	207	87.38
	9518	4210	5308	55.76
	20,933	12,495	8438	40.30

The comparative death-rate of limb-amputations in metropolitan and provincial hospitals, in large and small hospitals, and in hospitals and private country practice in Great Britain, was placed in a very striking point of view in 1870 by the researches of the late Sir James Y. Simpson. The results obtained by him may be arranged in tabular form.

Hospital.	Beds.	Amputations.	Recoveries.	Deaths—Ratio.
Metropolitan .	300 to 500	2089	1134	855 or 1 in 2.4
Provincial .	200 to 300	803	575	228 or 1 in 3.5
"	100 to 200	1370	1069	301 or 1 in 4.4
"	26 to 100	761	627	134 or 1 in 5.6
"	25 or under	143	123	20 or 1 in 7.1
Private practice .	. . . .	2098	1872	226 or 1 in 9.2
		6264	5400	1764 or 1 in 3.5

The results of the tables of Mr. Lane show, it will be perceived, in their aggregate relations, a mortality of 36.92 per cent., or one death in every 2.7 persons subjected to operation. Of the 1370 cases in the four American hospitals, 384 died, giving a mortality of 28 per cent., or one in every 3.5. Of the 6264 amputations analyzed by Sir James Y. Simpson, 1764, or 28 per cent., proved fatal, thereby affording a ratio of one in 3.5; while the mortality after amputation for gunshot injuries was 40 per cent., or one in every 2.48 cases.

CHAPTER XIX.

EXCISION OF BONES AND JOINTS.

THE term excision serves to denote the removal of a bone, whether in its continuity or at its extremity, whether it be limited to a portion of its extent or embrace its totality. When only the head of a bone is concerned in the operation, the word decapitation is occasionally used, and, as meaning the same thing, some authors have adopted the name of exsection, while others, especially the French and German surgeons, employ that of resection. Excision differs from amputation in this, that, while in the latter the bone is removed along with the soft parts which surround it, in the former the bone alone is cut away, the integument, muscles, and other tissues being retained, in order that they may contribute to the future usefulness of the limb; or, in other and more comprehensive language, while in the one case all the structures are destroyed, in the other as many of them as possible are preserved. Hence this department of surgery has very appropriately been denominated conservative surgery, and it is most gratifying to know that it constitutes one of the leading characteristics of the healing art of the present day. It is not to be expected that excision of the bones and joints will ever entirely supersede the necessity of amputation, for so long as the various tissues of the body are subject to disease and accident, so long will they require removal by the knife in order to prevent the extension of their effects; but that the frequency of the operation will eventually be greatly diminished, the experience of the last twenty years abundantly attests. Conservative surgery is still in its infancy, and it is needless to conceal the fact that it will take a long time to determine its legitimate limits.

Although incidental mention of excision of the bones occurs in the writings of some of the earlier surgeons, yet it is probable that, if such an operation was ever performed by them, it was in great measure, if not entirely, limited to the removal of the protruding ends of fractured bones. However this may be, it is certain that there is no well-authenticated case of excision of the heads of any of the bones until 1762, when Mr. Filkin, of Northwich, removed those of the knee-joint. Soon after this a similar service was performed for the superior extremity of the humerus by Vigaroux, David, and White. In 1781, Mr. Park, of Liverpool, repeated Filkin's operation, and, from the gratifying success attending it, he was led to propose its extension to all the principal articulations, much to the surprise of most of his contemporaries, who looked upon the measure as harsh and reckless. The consequence was that the procedure met with much opposition, and it might even have been entirely lost sight of if it had not been for the boldness and skill of Moreau, the elder, of Bar-sur-Ornain, who, towards the close of the last century, exsected, in rapid succession, the articular extremities of the shoulder, knee, and elbow. The success of the French surgeon was followed up by that of his son and successor, who obtained great celebrity for his operations upon the joints, attracting patients from all parts of France, and who, at various intervals, embodied the results of his observation and experience in separate monographs addressed to the Academy of Surgery at Paris and other learned societies. In the early part of the present century excision of the joints received a powerful and salutary impulse from the French army surgeons, particularly Larrey, Percy, Willaume, and Bottin, who repeatedly performed extirpation of the articular extremities of the bones, especially those of the shoulder, on account of gunshot injury. The operation, indeed, was performed, at one time, upon a large scale, and many limbs, as well as lives, were doubtless saved by it. Notwithstanding this, however, the procedure was generally regarded with suspicion in Great Britain, where, although it originated there, it made no actual progress until about fifty years ago, when, chiefly through the example of

Liston, Syme, and Ferguson, it began to attract universal attention among medical men. During the last third of a century the operation has been performed in numerous instances, by surgeons of the highest eminence, upon all the principal articulations, and the results have been such as to show that this department of the healing art now rests upon a solid and immutable basis. In this country excision of the joints was, until recently, greatly neglected, both in hospital and private practice : this, however, is no longer the case, for, since the civil war, the intelligence, zeal, and skill of our surgeons have nowhere been displayed to greater advantage in this branch of the healing art. All innovations require time for their adoption, and what De Condillac said of another subject is equally true of this. "Il est rare que l'on arrive tout-à-coup à l'évidence : dans toutes les sciences et dans tous les arts, on a commencé par une espèce de talonement."

Excision of the bones in their continuity has been practised, for various purposes, for a long time, and modern surgery is indebted to it for many of its most brilliant exploits. It is in this department, more particularly, that American operators have displayed their greatest skill. Commencing with excision of the inferior jaw by Dr. Deadrick, of Tennessee, in 1810, we may with just pride point to the operations of Mott upon the clavicle, of Mussey, McClellan, and Gilbert upon the scapula, of Butt and Carnochan upon the ulna, and of the latter upon the radius, not to mention numerous minor cases, which, although less known, have reflected the highest credit upon the scientific character of the profession, and conferred the greatest benefit upon a class of sufferers who would otherwise have been doomed to loss of limb and life.

The principal circumstances necessitating excision are, disease of the bones and joints, as caries and necrosis, gunshot, railway, and other injuries, and various kinds of deformity. The existence of malignant disease in or around an articulation contraindicates its performance. Excision has often been advantageously practised in ununited fractures, and it is also occasionally resorted to for the relief of deformity dependent upon ankylosis.

The most common cause for which excision is employed is caries of the bones, more especially of their articular extremities, and the operation, if properly executed, is generally followed by the most gratifying results, not only as it respects the life of the patient, but the usefulness of the limb. The operation is particularly adapted to chronic cases, in which the morbid action is in great degree arrested, and the system has become inured to suffering. Under opposite circumstances, it is liable to lead to disastrous effects, and should, therefore, if possible, be avoided.

In compound fractures and dislocations excision has been practised almost from time immemorial, and frequently with the most satisfactory results. In the latter of these accidents in particular, whether involving the large or small articulations, experience has shown that it is generally more safe, both as it respects limb and life, to resect the ends of the protruded bones than to restore them in the usual manner. In the ordinary reduction, the synovial membranes and cartilages are usually rapidly destroyed ; profuse suppuration takes place, and the patient gradually sinks under hectic irritation ; or if, after having struggled through the general danger, he at length escapes with his life, he is very liable to lose his limb, or, at all events, to have a permanently stiff, deformed, and useless joint.

Statistics of excisions for gunshot injuries will be given in a future chapter. Here I shall only observe that extended experience has demonstrated that the only large joints to which the procedure is at all applicable are the wrist, elbow, shoulder, and ankle. Performed upon the hip and knee, it is either promptly fatal, or so unsatisfactory as to require subsequent amputation.

Instruments.—Various instruments are required for the ready and successful performance of this operation, and it is always desirable to have rather too many than too few, so that every emergency may be promptly met as it arises. The incisions through the skin and muscles are made with ordinary scalpels, but for detaching the bones from the soft parts and dividing the ligaments, stout, probe-pointed knives, with broad steel handles, convex and semisharp at the end, will be necessary. Excision of the bone is effected with a hand-saw, a pair of pliers, or the gouge and chisel, according to the structure, size, and situation of the affected piece. The saw, which may be a common amputating one, should be from six to ten inches in length by three to twelve lines in width, its teeth being sharp and widely set, and its handle long and thick. A saw introduced by Mr. Butcher, of Dublin, and bearing his name, will be found very useful, especially when there is but little space, or when it is necessary to divide the bone obliquely. It has, as will be perceived by a reference to the engraving, fig. 230, a very narrow blade, the angle of which can be changed at pleasure. In addition to these instruments, it will be well to have upon the tray a Hey's saw, fig. 231, and also a very narrow concave saw, fig.

232, with a blunt end, in the event of its being necessary to divide the bone from behind forwards. As to the chain saw, fig. 233, even in its most approved forms, it may well

Fig. 230.
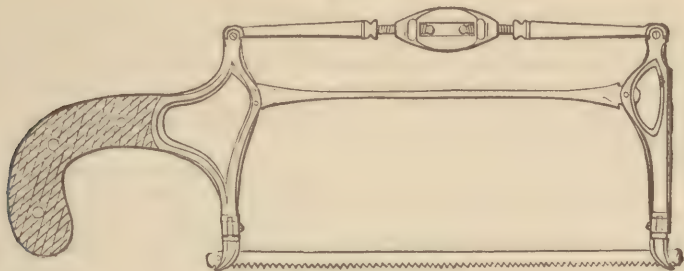
Butcher's Saw.

be dispensed with, as its use is generally only productive of delay, vexation, and disappointment. Bone forceps or pliers, figs. 234-35-36, usually known as Liston's,

Fig. 231.

Hey's Saw.

Fig. 232.

Curved Saw for Small Bones.

although long ago described and delineated by Scultetus, should be at hand, of various shapes and sizes, as they may frequently be employed with great advantage in places

Fig. 233.   Fig. 234.   Fig. 235.   Fig. 236.
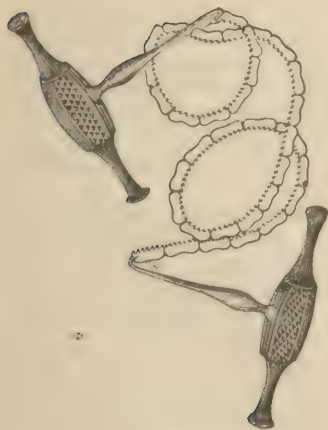
Chain Saw.   Bone Forceps.

where it is impossible to introduce and work the saw. The surgeon should also be provided with several gouges and chisels, a strong mallet, trephines, scrapers, and a large

elevator, together with a thick leather strap or leaden spatula for protecting the soft parts, during the division of the bone, suitable instruments for holding the flaps apart, and a syringe for washing out the wound or clearing away sawdust and the debris of diseased bone and cartilage.

The different steps of the operation will be greatly facilitated by the use of the elastic bandage, which, if skilfully applied, will render the proceeding completely bloodless. The ordinary tourniquet is not only unnecessary but absolutely hurtful by damming up the blood in the recent seat of the diseased structures. If proper care be taken, there will be no danger of laying open any of the larger arteries, none certainly that may not be readily secured by ligature.

Position of the Patient.—The position of the patient, the surgeon, and the assistants, as well as the number of the latter, varies in different cases and under different circumstances, and does not admit of any precise rules. Generally speaking, the recumbent posture will be the most suitable, especially if an anæsthetic is given and the operation is at all likely to prove tedious. In cases of any magnitude, as in exsection of the knee-joint, the number of assistants should not be less than five or six ; one administering the anæsthetic, two holding the limb, one handing instruments and tying arteries, and another having charge of the sponges.

As it respects the operation itself, it may conveniently be considered as consisting of three stages, the division of the soft parts, the excision of the bone, and the dressing of the wound.

Incisions.—In planning the incisions, care must, of course, be taken not to interfere with any structures, the division of which might compromise in any way the result of the operation. The sheaths of the tendons are to be especially avoided. To lay them open would be to invite inflammation and plastic deposit, which could not fail to impair their usefulness. The nervous trunks are turned aside, out of harm's way, and the larger vessels, both arterial and venous, are studiously protected from injury.

The number and direction of the incisions will necessarily vary in different cases. In most cases, even in such large joints as the hip and shoulder, a single longitudinal cut, either straight or more or less curvilinear, will be quite sufficient for the purpose. Langenbeck, who has acquired great distinction in this field of surgery, seldom employs any other incision than the simple longitudinal, and his success, as is well known, has been very extraordinary. Operations in which the parts are exposed by flaps of a semilunar, square, or horseshoe form, are seldom practised at the present day, it having been found that the wound is much longer in healing, and that the danger from erysipelas, pyemia, and other bad consequences is greatly increased. Incisions made after the manner of some of those depicted in the chapter on minor surgery will afford the surgeon an opportunity of adapting his operations to any case that will be likely to come under his observation.

The elliptical incision may be adopted, when it is necessary to remove diseased integuments, but, in any event, the great rule is to sacrifice as little soft substance as possible. Even when the flap is very large and unseemly, it must not be retrenched, experience having proved that it will always contract down to the proper dimensions during the progress of the cure. In separating the bone from its muscular and ligamentous connections, the knife must be kept as close as possible to its surface ; any deviation from this rule will be likely to be followed by the division of structures which should not be meddled with, especially important bloodvessels.

Removal of the Bone.—Insulation of the bone having been effected, it is next to be pushed through the wound, and excised, the parts around being carefully protected from injury by a piece of leather or a metallic spatula placed underneath. Whenever it is feasible, I prefer sawing off the bone to cutting it away with the pliers, as the surface thus made is more smooth, as well as less bruised, and, consequently, more liable to heal well. In operating upon the smaller bones, as those of the carpus and tarsus, we are generally obliged to make free use of the gouge and chisel. In whatever manner the excision may be accomplished, the invariable rule is to cut through the healthy structure ; and this is applicable even when the bone is merely denuded of its periosteum, observation having shown that, when the osseous tissue is divested of its natural covering, it is either already dead, or must soon die. In excision of the long bones, the condition of the medullary canal and its contents should always be carefully scrutinized, with a view of ascertaining whether the part should be still further retrenched or not. Imperfect excision is worse than useless, as no thorough cure can take place after it without another operation. Finally, when two bones require to be removed, as, for example, in excision

of the tibia and fibula, they should be sawed off upon the same level, otherwise the limb will be apt to be forced to one side, and so be rendered comparatively worthless.

In excision of the joints, none of the capsular ligament should be left, experience having shown that the danger from inflammation is materially increased when this precaution is neglected.

With the regard to the periosteum, the rule of practice is to preserve every particle not involved in disease. Of the value of this precept there can be no question, seeing what an important part this membrane plays in the formation, nourishment, and reproduction of the osseous tissue. In the chapter on diseases of the bones an instrument is represented which I have long employed for effecting the separation of the periosteum, and which is admirably adapted to such an object. It is a good plan always to raise the attachments of the muscles and tendons along with the periosteum, as its vitality is thus less likely to be interfered with. After the operation is over, the membrane should be thoroughly unfolded, and carefully spread over the surface of the wound.

In cases of long standing, requiring excision, the periosteum is generally very considerably thickened, and, therefore, comparatively easily detached, the reverse being true in excision performed in accidents and in cases of recent disease, in which the greatest care and patience are usually required to enable one to accomplish the object.

Dressing.—Bleeding having been arrested, the wound is washed out with cool water thrown in with a large syringe, in order to get rid of the sawdust, which, if allowed to remain, would act as foreign substance, liable to provoke suppuration and erysipelas, if not worse consequences. Any sinuses that may exist are also pared or laid open. The edges of the wound are then approximated by the interrupted suture and adhesive plaster, aided, if necessary, by a compress and bandage. The most dependent portion of the wound, however, should always be kept patent by means of a small tent or tube, to favor drainage. If this precaution be neglected, the result will be that the secretions, which are always more or less profuse after such an operation, will accumulate in the wound, thus not only impeding the cure, but often inducing necrosis of the bones, and affording an opportunity for the easy entrance of pus into the system.

Before the patient is returned to bed, the limb should be placed in the position in which it is to rest during the after-treatment, and kept perfectly quiet by means of appropriate apparatus. In excision of the inferior extremity osseous union is usually desired, as the limb would hardly be useful without it, and, hence, it will not be proper, as a rule, to make passive motion. In the upper extremity, however, this rule is not applicable; here motion is both sought for and attained at all hazard, an ankylosed wrist, elbow, or shoulder being of little value.

The great sources of danger, after excision of bones and joints, are excessive suppuration, pyemia, septicemia, hemorrhage, and erysipelas. These accidents are to be carefully guarded against by the ordinary means, and treated upon general principles in the event of their occurrence. If the convalescence is unusually protracted, and especially if the wound is slow in healing, if sinuses form, or if there is much discharge of an unhealthy character, there will be reason to suspect that the bones have again become diseased, and that further interference will be required before a cure can finally be effected.

The twitching of the muscles after these operations, so often interfering with the reparative process, and causing the patient intolerable anguish, is generally very promptly relieved by hypodermic injections of morphia, or by morphia and valerian administered by the mouth.

Statistics.—The statistics of excision of the bones and joints have been placed in a very prominent and satisfactory point of view by the researches of Dr. Richard M. Hodges, of Boston, and by Dr. Oscar Heyfelder, of St. Petersburg, in two excellent and exhaustive monographs, published in 1861. The subjoined tables, compiled by the latter of these writers, comprise the aggregate results of 2241 cases, of which 1280 relate to the bones, and 961 to the joints.

Excision of Bones.

	Cases.	Recoveries.	Deaths.	Failures.	Percentage deaths.
Extremities	605	471	60	74	9.91
Face	559	379	174	6	31.12
Trunk	116	82	32	2	27.58
	1280	932	266	82	36.04

Excision of Joints.

	Cases.	Recoveries.	Deaths.	Failures.	Percentage deaths.
Wrist	49	35	9	5	18.36
Elbow	286	205	32	49	11.18
Shoulder	196	131	30	8	15.30
Ankle	174	149	16	9	9.19
Knee	213	129	64	20	30.04
Hip	70	35	35	...	50
	961	684	186	91	36.78

From these tables it will be seen that in excision of the joints the smallest mortality is afforded by the ankle, and the largest by the hip. In regard to excision of the bones, the greatest percentage of fatal cases is furnished by the face. The mortality after all amputations, according to Mr. James R. Lane, calculated from a total of nearly 6000 cases, is as high as 36.92 per cent., or one in every 2.7 of the patients submitted to the operation.

Dr. S. W. Gross has collated the most extensive statistics of excision of the shafts of the bones for gunshot injuries, of which I have any knowledge. The subjoined table, compiled by him, comprises 1657 cases.

Excision of Bones.

	Cases.	Recoveries.	Deaths.	Percentage deaths.
Radius	359	311	48	13.37
Ulna	312	262	50	16.02
Radius and ulna	64	56	8	12.50
Humerus	700	496	204	29.14
Fibula	81	65	16	19.75
Tibia	72	57	15	20.83
Tibia and fibula	19	15	4	21.05
Femur	50	6	44	88
	1657	1268	389	23.47

In a recent exhaustive work on excision of the joints for gunshot injuries, Professor Gurlt, of Berlin, has analyzed 3667 cases, the results of which, as are shown in the following table, were determined in 3596.

Excision of Joints.

	Cases.	Recoveries.	Deaths.	Percentage deaths.
Wrist	132	112	20	15.15
Elbow	1403	1054	349	24.87
Shoulder	1634	1067	567	34.70
Ankle	145	94	51	35.17
Knee	144	33	111	77.08
Hip	138	16	122	88.40
	3596	2376	1220	33.92

It will thus be perceived that in excision of the long bones the smallest mortality is afforded by the radius and ulna, and the largest by the femur. In regard to excision of the joints, the smallest percentage of deaths is afforded by the wrist, and the largest by the hip. The aggregate mortality of the above cases is 30.63 per cent., while of the 20,933 amputations for gunshot injuries, according to Dr. Gross, 8438, or 40.30 per cent., proved fatal.

CHAPTER XX.

ANÆSTHETICS.

THE prevention of pain in surgical operations has been an object of anxious solicitude with practitioners from time immemorial, and we accordingly find that suggestions, more or less plausible, have been made at different periods with a view of meeting this important end. One of the most remarkable of these suggestions, inasmuch as it was a clear foreshadowing of the anæsthetics of the present day, occurs in the surgical writings of Theodoric, in the latter part of the thirteenth century. The means recommended by him consisted in thoroughly impregnating a sponge with a strong aqueous extract of various anodyne articles, especially opium, hemlock, hyoscyamus, lettuce, and mandragora, and then after having been immersed for an hour in warm water, holding it to the nose until the patient fell asleep, when the operation was proceeded with. In order to rouse him when the operation was over, another sponge, dipped in vinegar, took the place of the " spongia somnifera," as the former was denominated; and, if this expedient failed, the juice of the root of fenugreek was freely injected into the nostrils. In India, the extract of the hemp plant, cannabis Indica, indigenous to that country, has been employed for the same purpose for ages past. Near the close of the last century, great hopes were entertained that a successful agent had at length been found in the inhalation of nitrous oxide gas, either alone, or variously combined with other vapors; but after numerous experiments, in which Sir Humphry Davy and other eminent philosophers took an active part, the project was at length abandoned as chimerical. Some time prior to this period, Mr. Moore, of London, had suggested the possibility of diminishing pain in surgical operations, especially in amputations, by compression of the principal nerves, by means of an instrument, somewhat similar to a tourniquet, but so constructed as to constrict the limb only at two points, one of the pads being regulated by a screw. The experiment was tried at St. George's Hospital, by John Hunter, upon a man whose leg was cut off below the knee on account of a large, irritable ulcer of the foot, and the suffering is said to have been exceedingly slight. Very few, however, seemed inclined to repeat it, and the consequence was that it was soon given up; a result which might have been anticipated by the originator of the plan, as the instrument used for the compression was not only uncertain in its operation but productive of great uneasiness during its application.

In 1819, Mr. James Wardrop, of London, proposed to diminished the sensibility of the patient in surgical operations by means of copious venesection, and in a paper which he published on the subject in the tenth volume of the Medico-Chirurgical Transactions he cites several cases illustrative of its beneficial influence. He thought the practice particularly adapted to persons of a nervous, irritable temperament, and he recommended that it should be carried to the extent of syncope, so as completely to annul all sensation during the dissection. In one of his cases, he bled the patient, a young, robust woman, to fifty ounces before he began the operation, which consisted in the extirpation of a small tumor from the orbital plate of the frontal bone, during which she remained perfectly unconscious, expressing great surprise when she found it was over. As might have been expected, however, she remained very weak for several days after the operation, although she made a rapid recovery. I am not aware that this recommendation met with any particular favor.

The administration of the different preparations of opium for the purpose of lessening the pain in surgical operations is an old practice, highly lauded by some, and as greatly condemned by others. I was myself in the habit of employing it for many years in almost every case that fell into my hands previously to the discovery of anæsthetics: I generally preferred morphia to laudanum or opium in substance, and always gave it in full doses, either alone, or, when the patient was strong and plethoric, combined with a moderate quantity of tartrate of antimony and potassium, with a view of inducing a greater degree of relaxation and insensibility. I became very fond of the practice, and never, so far as I could determine, experienced any bad effects from it; on the contrary, I know that it

was commonly productive of great benefit, not only blunting sensibility but preventing shock, and, consequently, severe reaction.

Notwithstanding these various attempts to prevent suffering in surgical operations, no anæsthetic agent, using the term in its legitimate sense, was discovered until 1844, when Dr. Horace Wells, a dentist of Hartford, Connecticut, wishing to have a tooth extracted, rendered himself completely insensible by inhaling nitrous oxide gas; and he soon afterwards administered the same remedy to several of his patients with effects equally gratifying. Shortly after this, Dr. Wells repeated his experiment before the medical faculty and students of Harvard University at Boston, but, owing to mismanagement either in the apparatus or the gas itself, the attempt signally failed, and the only reward which he received for his pains was ridicule, which, in his case, was the more cruel, because he was a man of uncommon sensibility. Two years later, Dr. Morton, also a dentist, and a pupil of Wells, resorted to the inhalation of sulphuric ether, first in his own person, and afterwards in some of his patients, until he became convinced that it might be taken not only with impunity, but with the most perfect certainty of preventing pain in any operation, however severe or protracted. Fortified with this knowledge, he applied at the Massachusetts General Hospital, at Boston, for permission to repeat his experiments upon a man who was about to undergo an operation for the removal of a tumor of the neck by Dr. John C. Warren. The result was everything that could have been desired. The next day, Morton etherized a patient for Dr. Hayward; and the news of the remedy rapidly spreading, its use soon became general, both in the United States and in Europe. In the latter country the subject attracted perhaps even greater attention than at home, and soon led to the discovery of chloroform by Sir James Y. Simpson, of Edinburgh, in 1847. Various other articles possess anæsthetic properties, as chloride of hydrocarbon, nitrate of ethyl, aldehyd, benzin, the Dutch liquid—a compound of chlorine and olefiant gas—kerosoline, bisulphuret of carbon, amylen, protoxide of nitrogen, and bichloride of methylene, but, with the exception of the last three, it is questionable whether any of them are sufficiently innocuous to justify their exhibition.

Practically it is of no importance to know who the discoverer of anæsthetics was; but, if we carefully inquire into the history of the matter, we cannot fail to award to Dr. Wells the credit of having made the first successful application of this class of agents for the prevention of pain during a surgical operation. Nearly fifty years previously, Sir Humphry Davy had, it is true, employed nitrous oxide gas for the relief of a severe headache, brought on by the intoxication caused by the rapid drinking of a bottle of wine for experimental purposes, and afterwards as a means of preventing the pain in cutting the gum over a wisdom tooth; but, as every one knows, no further use of the remedy was made until it was resumed by Dr. Wells, and applied with express reference to the production of anæsthetic effects. He was beyond doubt the first to establish the possibility of preventing pain in surgical operations; and had his experiments at Boston not eventuated in chagrin and disappointment, he would unquestionably have pushed his researches much further, and perhaps speedily hit upon the very articles which were afterwards found by Dr. Morton and Professor Simpson to possess such valuable properties. To both the latter gentlemen the world owes an immense debt of gratitude for having brought to light the wonderful anæsthetic effects of ether and chloroform.

In an article in the Virginia Medical Monthly for May, 1877, J. Marion Sims has furnished evidence going to show that sulphuric ether was first intentionally employed as an anæsthetic in surgical operations in 1842, by Dr. C. W. Long, of Athens, Georgia. The only circumstance invalidating this claim is the persistent silence of Dr. Long and his friends during the long and heated controversies growing out of the labors of Wells, Morton, and Jackson. Hence, although he may have been, and probably was, the first to use this fluid as a means of preventing pain, he failed to interest the profession in it, and has thus lost all just claim to the honor of one of the greatest discoveries ever achieved by human genius.

It is not a little singular that the two countries in which the anæsthetic virtues of ether and chloroform were discovered should each, respectively, have preferred for many years its own remedy; America ether, and Great Britain chloroform. There are, however, in Great Britain, many surgeons who now employ ether, and in this country many practitioners who prefer the latter article, both in surgical and obstetrical practice, and I have myself constantly used it ever since its introduction among us in 1848, believing it to possess decided advantages over ether, although its administration unquestionably requires the greater care and attention. Among the more important of these advantages are, first, the more rapid manifestation of the anæsthetic action of the remedy, the system becoming

affected much sooner, as a general rule, than it does by ether; secondly, a smaller amount of laryngeal and bronchial irritation; thirdly, the more easy maintenance of the anæsthetic influence, after the system has once been fairly affected; and, lastly, the less liability to cause vomiting and other unpleasant consequences. The very odor of ether is to many persons excessively offensive, and there are very few in whom the inhalation does not produce more or less cough and vomiting. On the other hand, it certainly requires less caution in its administration, and thus far it has furnished but few deaths, whereas the mortality from chloroform is already above three hundred. Dr. Maddin, of Nashville, who has carefully investigated the subject, finds that most of the fatal cases of anæsthesia have occurred in minor surgery, or in operations of a comparatively trifling nature, and in which, consequently, the remedy might probably have been entirely dispensed with. For a number of these cases the dentist is accountable, nearly all the earlier and not a few also of the later having happened during the extraction of teeth, from the want of precaution in not sufficiently depressing the head during the operation.

It is remarkable that many of the fatal cases have occurred in private practice, or in small institutions, a circumstance which would seem to show that there had been some fault in the mode of administration of the remedy. At Guy's Hospital, London, chloroform had been employed in upwards of 12,000 cases before there was any serious accident; in the war in the Crimea, according to the testimony of Flourens, it was administered more than 25,000 times without a single death; and during the late war in this country there were, according to Dr. George A. Otis, only 8 cases out of upwards of 120,000 in which a fatal result could fairly be attributed to its use. Dr. J. S. Wellford, of Richmond, ascertained that, in the Confederate army, during the same period, chloroform was used in 22,000 cases without any accidents, and only one death in 15,000 cases is recorded by Professor Hunter McGuire.

From statistics collected from fourteen hospitals in London and Liverpool, in 1867, it appears that chloroform was administered in 83,059 cases, of which 24, or 1 in 3461, proved fatal. In the eye department of Guy's Hospital this article was employed, up to 1870, in 3221 cases without a single death, although 45 of the patients became blue in the face and suddenly stertorous, with irregular pulse and breathing.

Professor Andrews, of Chicago, in 1870, collected from different American and European hospitals the statistics of 117,078 cases in which chloroform was administered, with 43 deaths, affording thus a ratio of mortality of 1 to 2723. Of 92,815 cases, obtained in a similar way, of etherization, only four perished, or 1 to 23,204. A mixture of chloroform and ether was employed in 11,176 cases, of which only 2 died, the mortality being as 1 to 5588. Of the results of the administration of bichloride of methylene, all we know is that, up to 1872, in 7000 cases there had been only a few deaths.

In the hands of certain surgeons, the use of chloroform, as an anæsthetic agent, has been attended with astonishing success. I have now administered it in all kinds of operations in several thousand cases without a single death, and in only three cases did I feel any serious alarm for the safety of the patient. Syme gave it in about 5000 cases without any serious occurrence, and Simpson, it is said, met with only one death in all his immense experience. Professor Nussbaum, of Munich, in 15,000 cases, never lost a patient; and Billroth had no deaths in 12,500 cases. The results of the experience of other practitioners are equally gratifying. It is to be regretted than an agent capable of conferring such vast benefit should be so little employed in this country, because a fatal instance, produced, for the most part, by maladministration, is occasionally reported, as if death in surgical operations never arose from any other cause.

I ascribe my own success in the use of chloroform to the extraordinary care with which it has been administered in my practice, to the proper selection of my cases, and to the pains which have always been taken to procure a pure article, preference having generally been given to Squibb's preparation. An assistant who is accustomed to superintend the inhalation of chloroform is far safer than an inexperienced one, and neither in hospital nor private practice should any other ever be permitted to meddle with it.

It has been asserted by the opponents of chloroform that the rate of mortality in the great operations of surgery has been essentially increased since the introduction of that article into practice, and Mr. Arnott, of London, has taken pains to collect elaborate statistics with a view of establishing the fact upon an irrefragable basis. On the other hand, the statistics of Sir J. Y. Simpson, the discoverer of the anæsthetic properties of chloroform, go to show that the number of deaths is not only not increased, but absolutely diminished. Perhaps the truth lies between these two statements. Dr. Macleod, in his Notes on the Surgery of the War in the Crimea, published in 1858, declares it as his

conscientious belief that the use of chloroform in the British army saved many lives, and that numerous operations were performed by its assistance which could not otherwise have been attempted. It is not improbable that, if there has really been an increase in the mortality after operations since the introduction of anæsthetics, it has been owing, not to the pernicious effects of the remedy, but to the fact that surgeons have been emboldened to undertake operations in cases which were formerly regarded as unfit for the employment of the knife, and, above all, to the circumstance that of late years there has been a fearful increase of railway and other terrible accidents, many of which are necessarily fatal, no matter to what treatment they may be subjected.

Dr. Henry W. Davis, of Illinois, in a paper in the Chicago Medical Examiner for 1862, declares that chloroform, judiciously administered, so far from being a depressant, in severe shocks from gunshot injury, is a powerful stimulant, rapidly raising the pulse, and soon followed by healthy reaction. He states that he could cite numerous instances, presenting every degree of severity, but all attended with extreme prostration, in which the exhibition of this agent produced the most happy effects, and he adds that no amount of exhaustion, however intense, would induce him to withhold it, provided the lesion is recent. The experience of Dr. Davis has been confirmed by other observers, and I have myself seen a number of cases illustrative of the truth of his statements.

Anæsthetics not only prevent pain and mental suffering, but by placing the patient in a passive condition give the surgeon a control over him which he could not possibly obtain in any other manner. Deprived of sensibility and consciousness, the former is virtually dead to all external impressions, and permits the surgeon to conduct his dissections and other manual processes with as much ease and deliberation as if he were operating upon the cadaver. The advantages thus gained are absolutely incalculable, and he who would fully appreciate them must be able to put himself in the twofold situation of patient and surgeon, and then, in imagination, contrast their condition with that of the patient and surgeon of former times, before the discovery of anæsthetics, when the one was writhing in pain and agony during a tedious dissection, and the other had his progress incessantly interrupted by the cries and struggles of the sufferer.

The exhibition of anæsthetics is important not merely as a preventive of pain, but also as a means which enables us to investigate our cases more thoroughly prior to an operation. Exploration of the bladder, formerly a source of so much suffering, is now performed without the slightest uneasiness, and the same is true of stricture of the urethra, diseased bones, affections of the anus and rectum, and various other lesions. The use of anæsthetics affords immense advantages in the examination of dislocations and fractures, permitting us to handle the parts more satisfactorily, and, therefore, to form a more correct diagnosis.

There are some operations in which the use of anæsthetics is usually regarded as inadmissible; thus, in harelip, the excision of the tongue, and removal of the jaw, the patient, as a general rule, should be under the influence of these remedies only at the beginning of the procedure; after the dissection has been fairly commenced, he should be sufficiently conscious to enable him to coöperate with the surgeon, otherwise the blood, passing down into the windpipe, might cause severe cough and other inconvenience, seriously embarrassing him. The same remark applies to excision of the tonsils, although I have frequently removed these glands while the patient was so far under the influence of chloroform as to render him incapable of offering any resistance. Extirpation of the jaw I have repeatedly performed under similar circumstances, passing through the different stages of the operation while the person was in a state of perfect unconsciousness. Even the more delicate operations upon the eye, as the establishment of an artificial pupil, and the extraction of cataract, may be safely performed with the aid of anæsthetics, although, as it respects the latter, it should not be forgotten that the vomiting which occasionally attends their use might destroy the organ.

It has been asserted that one advantage of the use of anæsthetics is that it diminishes the liability to hemorrhage during an operation, but I have never been able to satisfy myself that this is true; nor have I any reason to believe, as has been so frequently alleged, that there is greater danger of secondary hemorrhage after the employment of these agents, due to loss of tone in the smaller vessels and to a decrease of coagulability of the blood. Both opinions are without proof.

Chloroform.—Chloroform, a terchloride of formyl, is a clear, colorless liquid, very volatile, of an agreeable, aromatic odor, of a pungent, saccharine taste, very dense, of the specific gravity of 1.500 at 60° Fahr., almost insoluble in water, non-inflammable, and perfectly neutral, neither reddening nor bleaching litmus paper. It is a compound

of three atoms of carbon, one of hydrogen, and three of chlorine. Various impurities are liable to be mixed up with it, especially the chlorinated pyrogenous oils, ether, and alcohol. The presence of oils is readily detected by pure, strong sulphuric acid, to which they impart a change of color, varying from yellowish to reddish-brown, according to the quantity of the extraneous substances. A still more simple test consists in pouring the suspected fluid upon the hand, where, rapidly evaporating, it deposits its oily impurities, which are easily recognizable by their offensive smell. Dropped upon white paper, pure chloroform speedily disappears without leaving any stain. The existence of alcohol is detected by dropping a small quantity of chloroform into distilled water; if pure, it will retain its transparency at the bottom of the glass, if not, each globule will acquire a milky appearance. The presence of ether may be detected by the inflammable character of the fluid. It is practically important to know that chloroform deteriorates by exposure to heat and to a strong light. The most reliable article is prepared with methylated spirit.

There are five principal circumstances which should be closely attended to during the exhibition of chloroform, and, if this be done, it will be difficult, unless the article is bad, or the patient has some idiosyncrasy, to produce any unpleasant effects with it. These are recumbency, an empty state of the stomach, a free play of the diaphragm, an abundance of atmospheric air, and a gradual administration.

1st. During etherization the patient may sit up with impunity, but this is not the case during the inhalation of chloroform, owing, apparently, to the greater relaxation of the muscles, and, consequently, to the increased difficulty in maintaining the circulation of the brain through the influence of the heart's action. Lying upon the side, when this is practicable, is perhaps the safest posture of all, as the breathing will then be less likely to suffer by the falling back of the tongue. The head should never be much raised, nor the neck bent.

2d. An empty state of the stomach is desirable for two reasons; first, because if chloroform be given soon after a heavy meal it will almost certainly induce vomiting; and, secondly, because a crowded condition of the organ interferes materially with the movements of the diaphragm. Food must not be taken for at least four hours before the exhibition; but, on the other hand, the interval should not be too protracted, lest serious exhaustion result from the want of necessary stimulus.

3d. Care must be taken, before the inhalation is commenced, that the patient's clothes are sufficiently loose to prevent constriction of the chest and abdomen. Any compression from this source would necessarily impede the action of the diaphragm, and might thus become a cause of mischief.

4th. The importance of having an abundance of atmospheric air during the inhalation of an article so potent as chloroform is self-evident; in etherization this is of comparatively little consequence, but in the exhibition of chloroform for surgical and obstetrical purposes it is absolutely indispensable to the safety of the patient.

5th. The inhalation must be effected gradually, not hurriedly, time being allowed the system to accommodate itself to the influence of the remedy, thus avoiding the shock which might otherwise be inflicted upon the heart and brain. From three to eight minutes should usually be spent in producing the full effects of the anæsthetic.

6th. When the patient is very feeble, or pale and timid, it will be advisable to give him immediately before the operation, from half an ounce to an ounce of brandy; and the dose may afterwards be repeated, if the effect is obliged to be maintained for an unusual length of time, sufficient consciousness being permitted for the performance of deglutition.

7th. It is a good plan, as a rule, to administer about an hour before the operation is begun a hypodermic injection of morphia to quiet the nervous system, and shorten or avert the stage of excitement, sustain the action of the heart, and prevent laryngeal and bronchial irritation. This has been my practice for many years at the College Hospital as well as with my private patients, and I have found no reason to regret it. Indeed I am satisfied that it not only adds greatly to the safety of the patient, but that it also renders anæsthesia possible with a less quantity of chloroform than is required under ordinary circumstances. Bonwill's method of rapid respiration also exercises an obtunding effect on the air passages, and may often be beneficially employed when the use of an anodyne is not deemed advisable or proper.

The best mode of administering chloroform is to pour the fluid upon a napkin or handkerchief, previously folded into a cone or cup-shaped hollow, and held securely in the hand. Or, instead of this, a small hollow sponge may be used. As to the various

inhalers that have been devised for the purpose, most of them are objectionable on account of their inconvenience and the difficulty of obtaining a sufficiency of atmospheric air. One of the best of these contrivances is that devised by Professor Chisholm, of Baltimore, used extensively in the Southern States during the late war. It consists of a metallic instrument, fitted for insertion into the nostrils, the mouth being left entirely free for breathing. In this way, anæsthesia is rapidly induced without any waste of fluid from evaporation even in the open air. The apparatus of Dr. Skinner, of Liverpool, a very simple and efficient one, consists of a wire frame in the shape of a shallow ladle covered with flannel, the concavity being held over the nose and mouth while the chloroform is dropped upon the convex surface. The apparatus of Mr. Clover, so extensively employed in London, is too troublesome and expensive for general use.

The patient having taken his place upon the table, and emptied his lungs by a deep and protracted expiration, the napkin, impregnated with a drachm of chloroform, is held over the mouth and nose, at a distance of about two inches, being gradually brought nearer and nearer until it is within one-fourth of that distance, beyond which it should not be carried, the chest being at the same time regularly and powerfully distended. The pungent effect of the liquid upon the skin should be prevented by anointing the face with some protective unguent, otherwise vesication may arise. All unnecessary conversation is avoided, lest the attention of the patient should thereby be unduly distracted. The assistant having charge of the administration gives it his earnest and undivided care, wetting the napkin from time to time with the fluid, and seeing that the patient obtains an abundance of air, his vigilance increasing as the effects of the medicine become more and more apparent. As soon as the sensibility is completely abolished, the operation is commenced, a return to consciousness being prevented by holding the napkin, sprinkled with a small quantity of the vapor, occasionally before the nose, and thus the impression is maintained, steadily and cautiously, not only until the knife has fully accomplished its object, but until the principal arteries have been secured, and, in some cases, even until the dressings have been applied.

As soon as the inhalation has been fairly entered upon, an attendant should sedulously watch the pulse, respiration, and countenance. If any sudden change be noticed in their condition, the administration must instantly be discontinued, or, if persisted in, conjoined with a more liberal supply of atmospheric air. It is not necessary that a finger should be constantly kept upon the pulse; for the color of the face and the nature of the breathing will always sufficiently indicate the effects which the anæsthetic is exerting upon the system, and thus afford abundant opportunity for preventing any unpleasant occurrence.

When chloroform acts as a decided depressant, as in excessive anemia, organic disease of the heart, or inordinate exhaustion from profuse discharge, the anæsthetic effect should be maintained with ether, experience having shown that, if it be not, in such an event, a positive antidote to the evil consequences of chloroform, it restores the force of the circulation, and may be administered without the slightest risk to life.

The quantity of chloroform required during an operation, and the time during which its effects may be safely maintained, must, of course, vary according to the exigencies of each particular case. In general, from half an ounce to an ounce may be regarded as a fair average, but very frequently it takes three, four, or even five times that amount, depending upon the severity and duration of the operation, and the susceptibility of the individual. In some instances almost an incredibly small portion answers the purpose. Children usually require comparatively little; and it is well known that women are generally more susceptible to its influence than men. Persons exhausted by hemorrhage are very easily affected by it, owing to the rapidity of its absorption, and hence it should always be administered to them with unusual care. In obstetric practice, the effects of chloroform may be maintained, with impunity, for many hours together, and the same remark is true of severe and tedious surgical operations. Thus, in an attempt to reduce a chronic dislocation of the shoulder-joint, I kept the patient steadily under the influence of the remedy for two hours, during which not less than twelve ounces were consumed.

Age is no bar to the use of anæsthetics. I have given chloroform repeatedly to very young children, and, in several instances, with excellent effect, even to infants under two months. In fact, the more tender the age is, the more easy is the induction of insensibility. Old persons also bear the inhalation well. On one occasion I gave it with the most gratifying effects to a lady of ninety-two, supposed to be laboring under a fracture of the neck of the thigh-bone. Certain diseases are very properly regarded as contraindicating the employment of chloroform, particularly organic lesions of the heart, lungs,

and brain, anemia, and the habitual use of intoxicating drinks. It should never be administered in cases of accidents attended with severe shock or loss of blood until after thorough reaction has taken place. In administering chloroform to infants and very young children, only a few drops should be poured upon the napkin at a time, and care should be taken to hold the cloth at a considerable distance from the mouth and nose, so that the fluid may enter the lungs well diluted with atmospheric air.

Effects.—The effects of chloroform upon the system may, for practical purposes, be divided into two stages, that of excitement, and that of insensibility. The first begins soon after the commencement of the inhalation, and is characterized by various cries and struggles, as if the patient, feeling alarmed, were anxious to escape from the table. The face becomes flushed, the eye has a wild and staring expression, the pulse is preternaturally frequent, and the mind is incoherent; as the effects increase, the brain falls into a species of exhilaration closely akin to that of intoxication. It is now that the individual usually exhibits his peculiarities of temperament and habit. Thus, if he is of a boisterous disposition, he will be apt to be noisy, to swear, or to fight, and to make the most violent efforts to disengage himself from the assistants. One man will laugh and joke; another will weep, or moan and sigh; the sportsman will fancy himself occupied in the pleasures of the chase; the wily craftsman, in driving a good bargain; the lawyer, in addressing a jury; the preacher, in exhorting his congregation; and the physician, in prescribing for his patient. The mind is in a dreamy, perverted condition, and whatever is most predominant at the time in thought and feeling is sure to exhibit itself in expression.

This excitement varies much both in degree and duration; in many cases it is very slight and transient, while in some it is even entirely wanting, the patient being perfectly tranquil throughout. When considerable, it is very liable to be reproduced, to a greater or less extent, as the effects of the remedy wear off, so that the individual will, perhaps, be quite as boisterous after the inhalation is over as he was soon after its commencement. In very nervous, excitable persons the intoxication may last for several hours, although this is uncommon.

In the second stage, which succeeds imperceptibly to the first, the individual gradually lapses into a state of entire unconsciousness; the muscles, thoroughly relaxed, are no longer under the control of the will, the limbs retaining any position in which they may be placed; the eyelids are closed and the balls turned up, the pupils being contracted, and insensible to light; the respiration is calm and easy; and the pulse is soft and undisturbed, or, if at all changed, it is rather below than above the normal frequency. Feeling and intellection are suspended, and everything indicates that the patient is in a quiet and pleasant sleep, wholly unconscious of surrounding objects, and, therefore, completely insensible to pain. If this state be carried a little further, coma will arise; the patient will snore as if he were apoplectic, the pulse and respiration will diminish in force and frequency, and the pupil will become notably dilated. As yet, all is safe, but a few more whiffs, and an important link in the chain of life may give way, and the patient be sent into eternity. In the administration of chloroform we should always strive to prevent coma. The most unexceptionable form of anæsthetization unquestionably is that in which there is a perfect suspension of sensibility without the complete abolition of consciousness; but it need hardly be added that it is, practically, extremely difficult to produce such a nice result in any case. In general, the patient, on recovering from the effects of the remedy, has no distinct recollection of anything that passed while he was under its influence.

The effects of chloroform seldom completely disappear under several hours. After the more characteristic symptoms have subsided, the mind will still be somewhat bewildered, the muscles relaxed, and the feelings perverted. In some cases, especially in children, the patient, after having passed through a most severe operation, will fall into a tranquil sleep, and, perhaps, not wake fully for an hour or two. In other cases, again, the effects go off very rapidly, and the individual will be roused not only to a state of consciousness, but to severe pain. When the vapor is very freely employed, there will frequently be some degree of nausea or even vomiting, either during the operation, or at its close, upon the return of consciousness. Emesis is most common in children and in persons of a nervous, irritable temperament, but may generally be entirely prevented by the administration of a little brandy or whiskey immediately before the inhalation of the anæsthetic is commenced. Headache, although infrequent, is occasionally met with, and may last for a number of hours. It is most liable to occur when impure chloroform is used.

I have never witnessed any permanently ill effects from the exhibition of chloroform, such as partial paralysis, loss of sensation, or perversion of taste and smell; and a similar

declaration has been recorded by the late Dr. Snow, of London, in his work on Anæsthetics, published in 1858.

Although chloroform is one of the greatest boons which a kind and beneficent Providence has bestowed upon man for the prevention and alleviation of pain, yet, like every other remedy, it is capable, when abused, or injudiciously administered, of producing the most deadly effects. These effects are those of a narcotic poison; and as they may follow, in persons of unusual susceptibility, the inhalation of the smallest quantity of the liquid, it is of the utmost importance that they should never, for a moment, be lost sight of in the use of the article. An overdose may destroy life almost instantaneously, or death may occur at a variable period after the exhibition; sometimes even after partial reaction has taken place. The phenomena indicative of danger are, stertorous respiration, a small, feeble pulse, lividity of the features, dilatation of the pupils, relaxation of the sphincters, and rapid diminution of the temperature of the body.

Death by chloroform may occur in at least four different ways, by coma, by asphyxia, by syncope, and by gastric irritability, as it effects the brain, the lungs, the heart, or the stomach. Dr. J. C. Reeve, of Ohio, who, in 1867, was at great pains to investigate the causes of death from the inhalation of this fluid by the examination of a large number of recorded cases, is of opinion that the fatal event is not unfrequently produced by mere shock, in the same manner as in a blow upon the stomach, or as when a draught of cold water is taken in an overheated state of the body.

Death by coma generally occurs suddenly, apparently from the absorption of the chloroform, and its direct sedative effect upon the brain; or, as is more probable, upon the brain and spinal cord. The occurrence is always preceded by stertorous breathing, by lividity of the surface, and by convulsive movements of the muscles, the action of the heart ceasing with the respiration, or even before the respiration is completely extinguished. Elderly persons, worn out by intemperance, protracted disease, and the depressing passions, are most subject to this mode of death.

In death by asphyxia the breathing stops suddenly, the heart continuing to beat for a short time after all motion of the chest has ceased. The occurrence is denoted by the gasping character of the respiration, the lividity of the features, the distension of the jugular veins, the flickering nature of the pulse, and the dilated and insensible condition of the pupils. Death takes place, not directly from the effects of the chloroform, but indirectly from deprivation of oxygen, the anæsthetic not having been admixed with a sufficient quantity of air during its inhalation.

In death by syncope from an overdose of chloroform the fatal event is due to paralysis of the heart, or the sudden abstraction of nervous fluid, the patient dying very much as in shock, induced, perhaps, only by a very few inhalations. The heart ceases to beat before the breathing, the countenance is of a ghastly, livid hue, the pulse is weak and flickering, and life is usually destroyed very suddenly. Persons with a soft, flabby heart, accompanied with fatty degeneration of its muscular structure, and dilatation of the left ventricle, are most liable to suffer in this way.

Death from gastric irritability does not occur suddenly but gradually, not perhaps under several days, the primary impression being apparently made upon the pneumogastric nerves, and the secondary upon the brain, heart, and lungs. The event is uncommon. In a typical case, a very remarkable one of its kind, observed by the late Dr. Thomas Wood, of Cincinnati, the very first inhalation produced retching, followed by vomiting before the patient became insensible; the anæsthesia was maintained for half an hour, and, on the return of consciousness, the gastric trouble reappeared, and continued until the close of life on the sixth day. The retching and vomiting, in this case, were evidently, in the first instance, entirely independent of any cerebral disturbance, although, in its progress, both the brain, the lungs, and the heart became seriously implicated, as is shown by the fact that at the end of twenty-four hours there was delirium, with tremulous movements of the muscles, dilatation of the pupils, and lividity of the general surface, symptoms which steadily persisted up to the time of death. When a person, after having been comatose or asphyxiated, partially recovers, he may linger for several hours, or even a much longer period, in a state of partial unconsciousness, and finally die under all the symptoms of profound congestion of the brain and lungs, with a tendency to serous effusion and deposits of lymph; or he may gradually regain his health, without, perhaps, any bad ulterior effects.

The repeated inhalation of chloroform does not seem to establish a tolerance of the remedy, or to serve as a security against a fatal occurrence. A very considerable percentage of the recorded deaths by this agent took place during the inhalation for the

second, third, or fourth time.   To produce a fatal effect, it is not necessary that the quantity of chloroform should be large or that the inhalation should be at all protracted. Frequently a few hurried whiffs are sufficient.   Of 102 cases of death from chloroform, tabulated by Sansom, in which the stage of anæsthesia was noted, 50 perished before the full effects of the remedy were produced.

When death ensues from these trivial causes, the probability is that the event is generally dependent upon extraneous circumstances, as the idiosyncrasy of the individual, the amount of shock or loss of blood, exhaustion from disease, an overloaded state of the stomach, the semierect posture, mental emotion, and other untoward conditions of the system, not always appreciable before the inhalation is begun.   The baneful influence of fear in debilitating the system is well known ; and it is not to be forgotten that a person, although pretty completely influenced by chloroform, may suffer violently from shock induced by a severe and protracted operation.

Treatment.—The treatment for the relief of the poisoning consequent upon an overdose of chloroform must be prompt and efficient ; for everything depends upon the surgeon's presence of mind and the rapidity and energy with which he applies his remedies.   The first thing to be done is to desist from the further administration of the remedy ; the second, to place the head below the general level of the body, and to draw the tongue out of the mouth with a towel or tenaculum, so as to lift it away from the glottis ; the third, to cause a full access of cold air, by throwing open the doors and windows of the apartment, and making free use of the fan ; the fourth, to dash cold water upon the body, or still better, to pour it from a height of several feet ; the fifth, to institute artificial respiration, by introducing a tube into the windpipe and percussing the body, or blowing air into the mouth ; the sixth, to stimulate the surface, especially over the spine and heart, with hot mustard water, lotions of veratria, or dilute spirit of hartshorn ; the seventh, to administer an injection of turpentine ; and the last, to apply galvanic electricity, passed through needles inserted into different parts of the body, more especially over the heart, diaphragm, and spine.   A lump of ice inserted into the rectum often produces an excellent effect.   "Flipping" the surface with the end of a towel wrung out of cold water is a powerful excitant.   As soon as the patient is able to swallow, free use is made of brandy and ammonia.   These means should be employed with great diligence and regularity until it is perfectly evident that life is irrecoverably extinct.

Striking the patient with the flat hand, sharply and rapidly, upon all parts of the body —the face, trunk, arms, and legs—is worthy of trial.   The clothes, as a preliminary step, should be removed as speedily as possible, and the efforts should be uninterruptedly continued until there is a return of breathing and pulsation.   Accoucheurs often resort to this process of reviving stillborn children ; it is a powerful stimulus making its primary impression upon the sensitive nerves of the skin, and through them, by reflex action, upon the spinal cord, the heart, and the capillaries.   Striking the surface gently and rapidly with small switches, or the end of a fringed towel wrung out of ice water, is often of great service ; and there is, according to my experience, no more powerful excitant than a strong solution of veratria rubbed freely and roughly upon the back and chest. Mouth to mouth insufflation is also a very valuable method of resuscitation in chloroform poisoning.   To render it effective, the larynx should be pressed against the spine, to prevent the air from passing into the œsophagus, and the insufflation should not be performed too rapidly or too forcibly, lest the lungs be injured.

The late Professor Nélaton, of Paris, under a conviction that death from the use of chloroform is due to syncope or anemia of the brain, strongly recommended inversion of the body, thus rendering the head the most dependent portion, and at the same time keeping up steady artificial respiration.   Numerous cases successfully treated by this method have been recorded by different observers, and there is no longer any doubt respecting its efficacy.

The inhalation of the vapor of ten to fifteen drops of nitrite of amyl has frequently proved successful in restoring the heart's action, and the agent should always be in readiness whenever chloroform is exhibited.

For the minor effects of chloroform very little is necessary, beyond a discontinuance of the inhalation, sprinkling the face and chest with cold water, allowing a free access of cold air, and passing a smelling bottle rapidly to and fro under the nose.   If any lividity exist, indicative of impending asphyxia, the tongue must immediately be pulled out and steadily held till the breathing is fully reëstablished.

If vomiting occur, the patient must instantly be turned upon his side—not on his abdomen, lest the action of the diaphragm be impeded—with the head inclining down-

wards, otherwise the contents of the stomach, as they are lazily ejected from the œsophagus and fauces, might easily descend into the larynx, and thus induce suffocation. When the gastric distress is obstinate or protracted, the best remedies are brandy and a hypodermic injection of morphia.

In women, the unconsciousness, consequent upon the inhalation of chloroform, sometimes continues so long as to cause serious alarm for the safety of the patient. Such apprehension, however, is generally groundless, experience having shown that, when this state lasts beyond half an hour, it is due to hysteria, and not to the effects of the anæsthetic. Sometimes convulsions are induced, but they always promptly subside under the continuance of the inhalation.

Anæsthetics should never be administered to women except in the presence of witnesses. The cases of the two dentists, the one of this city and the other of Montreal, which some years ago created so much excitement both in and out of the profession, show that no man's character, however pure or exalted, may altogether escape censure, if, indeed, ruin. The remarkable instance which, a few years ago, occurred at the Philadelphia Hospital, of a woman who, while under the influence of anæsthesia, went through all the movements of the sexual congress, and analogous examples reported in the medical journals, clearly prove how strongly the imagination of the patient may be impressed in this way, while thus affected, and how vividly the idea may remain after the ordinary effects have passed off.

Ether.—The administration of sulphuric ether may be effected with a large, broad sponge covered with soft leather, with a towel inclosed in a thick paper cone, or, what is far better, and much more economical, with the inhaler of Dr. Oscar Allis, of Philadelphia, or of Dr. Lente, of New York, the latter of which is represented in fig. 237. The apparatus essentially consists of a bottle, a gum-elastic tube fitted with a stopcock, and a light, helmet-shaped framework, covered with two layers of flannel. Upon inverting the bottle and holding it above the mouth-piece, the ether diffuses itself very rapidly, the quantity used at the commencement of the operation being about two drachms, succeeded by three more as soon as the patient begins to respire fully, the effect being thus maintained until complete anæsthesia is induced. When the inhaler is removed from the face, as when stertorous breathing ensues, it must be placed on its base, to prevent the escape of vapor. The quantity of ether consumed does not, ordinarily, exceed two or three ounces, and from four to five minutes usually suffice to effect the desired object.

Fig. 237.

Lente's Inhaler.

When the inhalation is effected with a sponge or towel, not less than half an ounce of ether should be used in the first instance, and the administration should be steadily continued until the full object is attained, which often occupies from five to ten minutes. No particular attention need be paid to the admission of atmospheric air, as this fluid possesses none of the poisonous properties of chloroform. The quantity of ether consumed in this mode of administration is seldom, in ordinary cases, less than from four to eight ounces, while in the more protracted, twice or even thrice that amount may be necessary.

The first effect of the inhalation of ether is usually a short, hacking cough, but this soon subsides, and the system gradually lapses into a calm, quiet condition, attended with muscular relaxation, closure of the eyelids, and mental obliviousness, followed, in many cases, especially if the head lie low, and the tongue be permitted to fall back, by stertorous respiration. Sickness and vomiting are common occurrences; and occasionally there are spasmodic or tetanic movements, the body being thrown forcibly and convulsively backwards, as in opisthotonos. After the patient recovers his consciousness he often complains of severe headache, sometimes lasting upwards of twenty-four hours. Moreover, the breath usually retains for a long time, occasionally, indeed, for several days, the disagreeable odor of the anæsthetic.

In administering chloroform, the patient must always be recumbent; in etherization, on the contrary, he may sit up, or recline, as may be most convenient to the operator, no injury resulting even from the protracted maintenance of the erect posture. The inhalation, too, may be carried on more rapidly, and, as already stated, without any special

reference to the admixture of atmospheric air, a sufficiency always entering through the inhaler. Any bad effects that may arise from etherization should be treated upon the same general principles as those produced by an overdose of chloroform. The cold douche, in particular, will be of much service in recalling the patient to consciousness. The head should be depressed and the tongue drawn out if there be stertorous breathing, and the patient rolled upon his side and the ether withheld, if there be spasmodic, tetanic, or convulsive movements of the body. All the different varieties of ether possess anæsthetic properties; but the one universally preferred is the sulphuric, thoroughly washed, and divested of impurities. It is the article which Dr. Morton originally introduced to the notice of the profession under the name of letheon, or pain-destroyer, and which is now so much employed in surgical and midwifery practice in this country.

Some practitioners prefer a mixture of ether and chloroform to either of these articles alone, considering it to be equally efficacious, and at the same time more safe. I have myself frequently employed them in this way, and regard the combination as unobjectionable in every respect. The ordinary proportion is three parts of sulphuric ether to one of chloroform; but the quantity of either agent may be increased or diminished, according to the exigencies of the case, or the whim, fancy, or caprice of the surgeon. A mixture of equal parts of chloroform and alcohol was recommended by Dr. Snow, and is generally regarded as a very safe and efficient anæsthetic. In administering it to very young children, it may be diluted with rectified spirit, although, if proper care be taken, this is not at all essential, either to safety or convenience. Dr. Washington L. Atlee used one part by measure of chloroform and two of pure sulphuric ether in 300 ovarian operations without a solitary loss. The "Vienna Mixture," as it is termed, is made up of six parts of ether and two of chloroform; and has been administered in 8000 cases without one fatal result.

The committee appointed by the Medico-Chirurgical Society of London, in 1864, to examine into the merits of different anæsthetics, arrived at the conclusion that the safest way to administer chloroform is to combine two parts of this article with one of pure alcohol and three of concentrated ether. The superiority of this mixture is due, the committee allege, to the stimulating influence of the alcohol, and to its modifying effect upon the rate of evaporation of the two other constituents. The perfect safety of the mixture when properly administered, is fully attested by the experience of many of the best practitioners both at home and abroad.

In administering ether for surgical purposes in which the hot iron or galvanic cautery is employed, as, for instance, in operations about the face, mouth, or jaws, great caution must be exercised, otherwise the fluid, which is a highly inflammable one, may burn the patient or ignite his clothing. The flame of a lamp held in close proximity to the vapor is especially dangerous.

How the inhalation of ether proves fatal has not been decided. When death occurs promptly, as during, or very soon after, the administration, the probability is that it is caused by asphyxia, whereas when it occurs at a later period, as after the lapse of hours or days, there is reason to believe that it is due to the effects of congestion of the brain and lungs, either alone, or in conjunction with gastric irritability, which often exists in a most distressing degree. The number of deaths occasioned by the administration of ether is by no means inconsiderable. Hence the greatest caution should be used when employed as an anæsthetic. Old, sickly subjects, especially such as labor under fatty degeneration of the heart, seem to be most liable to suffer from its depressing effects. Lividity of the countenance or sterterous breathing imperatively demand the prompt suppression of its administration and the employment of restoratives.

Ethyl Bromide or Hybromic Ether, a compound of bromine, alcohol, and ether, is an anæsthetic that was at one time largely used by the late Mr. Nunneley, of Leeds, and subsequently strongly recommended by Dr. Richardson, of London. An atmosphere containing from eight to ten per cent. of the vapor causes, when inhaled, rapid reduction of the common sensibility, the pulse and breathing remaining tranquil, and the expression of the countenance good. Owing to the rapid transition from the first to the third stage of narcotism, there is little, if any, muscular excitement. No apnœa occurs, and the recovery is usually very prompt. An attempt was made a few years ago, in this city, by Dr. Laurence Turnbull and Dr. Richard J. Levis, to recall the attention of the profession to the use of this substance as an anæsthetic agent; but, owing to several deaths, occurring in pretty quick succession from its exhibition, it has again fallen into disrepute as a safe and reliable article, and it is not at all likely that it will ever again be aroused from its slumbers.

Bichloride of Methylene.—Bichloride of methylene, or chloromethyl, as it may be more properly called, was introduced into practice, as a general anæsthetic agent, in 1867, by Dr. B. W. Richardson, who administered it for the first time to the human subject in October in that year, in a case of ovariotomy performed by Mr. T. Spencer Wells. It possesses many of the properties of chloroform, but differs from it in having a sweeter odor, in being more pleasant to inhale, and in containing one atom more of hydrogen and one atom less of chlorine. It resembles ether in being inflammable in air. As an anæsthetic it causes less excitement than chloroform, is not so liable to produce vomiting, is more persistent in its action, and does not provoke rigidity of the muscles of the jaw, or lividity of the countenance. The sleep is usually very gentle, and with proper care may be maintained without injury for any reasonable time. Complete narcotism may be induced with from one and a half to three drachms in adults, and in children with less than one-third of that quantity. Like chloroform, it may be administered at all periods of life and in all kinds of operations, in the most severe and protracted as well as in the most simple and expeditious.

The mode of administering chloromethyl and the precautions with regard to the patient, as recumbency, emptiness of stomach, and absence of constriction, are the same as in the induction of anæsthesia with chloroform. The fluid may either be poured upon a thickly-folded napkin or it may be placed in an inhaler carefully fitted to the nose, from half a drachm to a drachm being used in the first instance, and a smaller quantity at each repetition until the desired effect is induced, when the anæsthetic influence may readily be maintained with a few drops applied from time to time as long as may be necessary. Air must, of course, be admitted, but not too freely, more especially at first, otherwise it will retard the induction of narcotism. A slight choking condition is often experienced at the beginning of the administration, but this usually passes off rapidly; if not, the inhalation must be momentarily suspended. Any ill effects that may arise must be treated upon the same general principles as in poisoning from chloroform. The agent is more dangerous than chloroform, and it has caused death in a number of instances.

Protoxide of Nitrogen.—This substance, better known as nitrous oxide gas, or laughing gas, was originally employed as an anæsthetic agent by Dr. Beddoes and Sir Humphry Davy, and afterwards by Dr. Horace Wells, of Connecticut, who was the first to administer it successfully for surgical purposes. It is a sweetish, colorless gas, destitute of odor, and is composed of equal parts of nitrogen and oxygen. When perfectly pure, and unmixed with atmospheric air, it is a supporter of vitality and of combustion, and, therefore, entirely safe as an anæsthetic. Its effects are very similar to those of carbonic acid gas, and hence its administration cannot be continued beyond a few minutes without the risk of asphyxia. For this reason it cannot be safely employed in protracted operations. Anæsthesia generally follows in from thirty to sixty seconds, snoring with unconsciousness being usually the first evidence of its induction. The pulse is slightly accelerated, the muscles are relaxed, the lips are livid, the eyes are rolled up, the conjunctiva is insensible, and, if the inhalation be at all protracted, the respiration will be considerably embarrassed and the blood of a dark color, owing to the absence of oxygen. Unless the stomach is loaded with ingesta, there is seldom any vomiting. In the female a good deal of hysterical excitement occasionally occurs. No secondary effects, such as sick headache, mental depression, nausea, or emesis, are liable to arise from its use.

The administration of this gas is effected by means of a gum-elastic inhaler, to which is attached a long tube of similar material, furnished with a mouth-piece, a cylinder of wood, fastened to a string, being previously interposed between the jaws. Recumbency need not be observed, as in the case of chloroform, but it is well to free the body from all constriction. Alarming symptoms are promptly relieved by a supply of fresh air. From six to eight gallons of the fresh gas is the quantity usually required to produce complete anæsthesia. It is proper to add that its effects are weakened by keeping.

Protoxide of nitrogen is more particularly applicable to the minor operations of surgery, as the extraction of teeth, the evacuation of abscesses, the removal of small tumors, and the ligation of hemorrhoids; but it may also be employed in some of the larger operations, as excision of the mammary gland, lithotomy, the perineal section, and the more ordinary amputations. Its great disadvantage is the rapidity with which it loses its anæsthetic effects. It should be given with great caution, if at all, in organic disease of the heart, in pulmonary phthisis, and in congestion of the brain.

Dr. John D. Thomas, of this city, informs me that, up to January, 1882, this gas had been administered by him and his brother, the late Dr. Franklin R. Thomas, since 1865, to 101,500 persons for the extraction of teeth, without one fatal accident. Included in

these cases are two amputations, one of the leg and one of the foot, and operations for sounding for stone in the bladder, anal fistule, clubfoot, and stricture of the urethra. The ages of the patients varied from three to ninety-two. Although some of them labored under organic maladies of the heart and lungs, asthmatic complaints, and various other complications, none experienced any ill effects. Nervous, hysterical women occasionally suffer from temporary depression, which, however, generally readily yields under the use of a glass of sherry or a little brandy and water. Persons in the advanced stages of disease of any important organ, anemic persons, and persons who are liable to frequent attacks of epilepsy, cannot with safety use the gas in this form. The number of deaths from the exhibition of this gas in the hands of different operators probably does not exceed a dozen.

Of all the anæsthetics now before the profession ether is unquestionably the safest, and is the one now universally employed in the hospitals of this country. In private practice, too, it enjoys a decided preference, although there are still many surgeons who use chloroform, believing that, if carefully administered, it is equally free from danger. For many years, I never employed any other article, and even now my confidence in its safety remains unshaken. For some time past, however, I have, in great measure, restricted myself, both in public and private practice, to the use of ether, except in the case of children, in whom I generally prefer chloroform on account of the rapidity of its action and the absence of unpleasant secondary effects. No article that has yet been tried as a means of averting pain is perfectly safe. Anæsthesia is, in almost any event, partial death; and hence no matter what substance may be used for inducing it, the occasional destruction of life must be inevitable.

The danger of the use of chloroform as an anæsthetic may, as a rule, be materially lessened by the administration of a dose of morphia, laudanum, or black drop, within an hour to an hour and a half of the operation. This practice has long been in force in all my more severe clinical cases, and I have the greatest confidence in its efficacy, not only in sustaining the heart's action, which the different preparations of opium are so well known to do, but in preventing the cough, excitement, and muscular rigidity so often witnessed, especially in nervous persons. What is true of chloroform in this respect is still more true of ether, which rarely fails to cause more or less severe and annoying laryngeal and tracheo-bronchial irritation, not unfrequently followed by partial asphyxia due to spasm of the laryngeal muscles. When a full anodyne is given in this way—not, as some have recommended, just before the administration of the ether or chloroform is commenced—I am satisfied from long experience that the agent acts not only more kindly but also much more speedily; that its use may be prolonged with much less danger; and that its after-effects are more promptly recovered from, with less tendency to the nausea and distress in the head so liable to follow, when this practice is neglected, the administration of ether.

At my Clinic at the Jefferson Medical College Hospital where, until recently, I employed chloroform in all my operations, no mishap from its use has ever occurred. Dr. Joseph Hearn, who has been my anæsthetizer for the last eleven years, has given it in many hundred cases, at all periods of life and under almost every variety of disease and accident without any serious occurrence. The fluid, whether chloroform or ether, is always administered gradually, during recumbency, on the empty stomach, with all sources of constriction removed; the respiration and circulation are carefully watched; and a wet towel is always at hand to slap the face the moment any signs of asphyxia appear. In regard to chloroform, my conviction is that there is less risk in the agent itself, provided it is perfectly pure, than there is in the mode of administering it.

It is worthy of remembrance, in regard to the use of anæsthetics, that, as rapid respiration obtunds the morbid sensibility of the respiratory passages, it may often be advantageously employed to prevent the unpleasant primary irritant effects of ether and chloroform inhalation, especially of the former.

For many of the minor operations of surgery, as the opening of boils and abscesses, the ligation of hemorrhoids, and the exploration of the bladder, complete anæsthesia is unnecessary. In such and similar cases, the knife and whatever else may be required, may very properly be employed the moment partial unconsciousness is obtained. Very frequently, indeed, a few whiffs of chloroform are quite sufficient for the purpose, especially in children. I have pursued this method for many years both in private and hospital practice, and its importance has been ably discussed in a paper published upon the subject in 1877 by Dr. John A. Packard, of this city.

Rapid breathing, as a means of preventing pain, was introduced to the notice of the

profession a few years ago by Dr. William G. A. Bonwill, an eminent dentist of this city, and is worthy of more attention than has hitherto been accorded to it. It is, of course, adapted only to minor operations, such as the opening of abscesses, the division of strictures of the urethra, the extraction of teeth, and the explorations of the bladder, vagina, and rectum for the detection and diagnosis of diseases. To produce anything like marked insensibility the number of inspirations should not be less than forty, forty-five, or fifty in the minute, steadily continued for three to five times that period. The best posture is the recumbent, but the sitting posture is not objectionable, provided there are no contraindications. The first effect is generally a feeling of fatigue, with a sense of tingling and of expansion or fullness in different parts of the body. Consciousness is preserved but not always in its full extent; the heart's action is increased in frequency and somewhat weakened; and, when the breathing is carried to an extreme degree, the countenance becomes cyanosed and the patient is seized with dizziness, confusion of ideas, lassitude, and incapability of resistance. These phenomena speedily subside on discontinuing the breathing. In operations it has been noticed that the blood which follows the knife is, when the system is fully impressed, of a venous color. The condition induced by rapid respirations strongly resembles that induced by the inhalation of nitrous oxide gas, and seems, to depend essentially, as Dr. Addinell Hewson, who has paid much attention to the subject, imagines, upon a diminished oxidation and decarbonization of the blood.

This mode of inducing anæsthesia should be practised with a certain degree of care in elderly persons worn out by long-continued suffering, and in persons laboring under organic disease of the heart with a tendency to apoplexy.

Local Anæsthesia.—Various plans have been tried for the purpose of inducing local anæsthesia, but the results have not been such as to hold out much encouragement for their practical application. When we consider the absorbent powers of the skin, it might reasonably be supposed that the endermic use of the more potent anodynes, as opium and its different preparations, aconite, belladonna, hyoscyamus, and kindred articles, might be employed beneficially in this wise, but experience has proved that any effect of this kind that they may possess is exceedingly transient and altogether incapable of serving as a preventive of pain during the application of the knife. The employment of ice, or of the frigorific mixture recommended by Mr. James Arnott, of London, is hardly entitled to more confidence; my experience with it is, it is true, very limited, but I have seen enough of it to satisfy me that its value has been greatly overrated, and that it can never, except, perhaps, in the most trivial cases of injury and disease, be carried to a sufficient extent to prevent pain in surgical operations. In a case in which I tried it during the removal of the mammary gland in an old lady, although the skin and subcutaneous connective tissue were completely congealed, the ice in the latter producing a crackling noise, yet the suffering was most intense, especially during the dissection of the deeper structures, where the effects of the freezing mixture had evidently not penetrated. No one can deny that, in this instance, the remedy had not been carried to a sufficient extent, and yet it certainly exercised but a very feeble influence as an anæsthetic. Besides, the application is not without risk, as the part, if not carefully watched, may be frostbitten, and thus experience unpleasant secondary effects.

Mr. Arnott's freezing mixture consists of two parts of ice and one of common salt, the former being previously reduced to a fine powder in a canvas bag, pounded with a flatiron. The latter should also be pulverized. The two articles are then thoroughly and quickly mixed, either with a knife, or by stirring them together in a gutta-percha or other non-conducting vessel. The mixture is inclosed in thin gauze netting, and as soon as the action of the salt upon the ice is rendered apparent by the dripping of the brine, it is placed upon the part to be benumbed, which is held in a horizontal position during the application. The netting should occasionally be raised to watch and equalize the effect of the remedy. About a quarter of a pound of ice and half that quantity of salt suffice for an ordinary application.

The first effect of the remedy is to chill the part, but this rapidly disappears, and is succeeded by pallor of the surface and a sense of numbness. Very soon the skin is found to be notably shrunken, and to assume a deadly, tallow-like appearance, at the same time that it is rendered somewhat stiff and perfectly insensible. If the application be continued longer, the subcutaneous connective and fatty tissues become partially congealed, as is proved by the fact that they feel hard and crackle slightly under the finger. When the application is properly made, that is, gradually and cautiously, the netting being occasionally raised for the purpose of inspection, it is perfectly harmless and almost unattended with suffering. It is only when it is continued too long that it is likely to be productive

of mischief.   Ordinarily from fifteen minutes to half an hour will be required to secure the desired anæsthetic effect.

Rhigoline, introduced as an anæsthetic, in 1866, by Professor Henry J. Bigelow, produces its specific effects by evaporation, freezing the skin firmly in from five to ten seconds.   Gently applied, the impression is evanescent ; protractedly, it is followed by discoloration of the surface and desquamation of the cuticle.   Rhigoline is particularly serviceable in opening abscesses and felons, in the removal of small tumors, in amputations of the fingers and toes, in phimosis, hemorrhoids, anal fistule, and other minor operations.   The only objection to it is its inflammable character, which prevents it from being conveniently carried about in hot weather.

The method of inducing local anæsthesia with the *ether spray*, devised by Dr. B. W. Richardson, consists in directing upon the part to be operated upon a series of jets of pure rectified ether by means of a small hand-bellows connected with a double tube

Fig. 238.
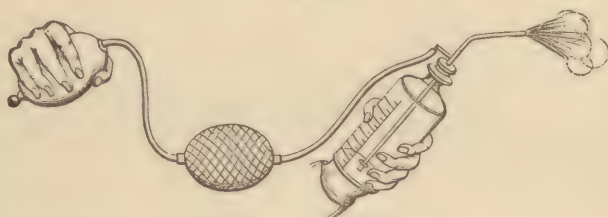
Richardson's Spray Apparatus.

inserted into a graduated bottle through a perforated cork, as represented in fig. 238. An intense degree of cold may thus be produced, rendering the skin insensible in less than a minute, and the narcotism may, if necessary, be readily extended, after the part has been incised, to any depth that may be desired.   With the aid of a spray catheter, the fluid may be thrown into the nose, rectum, bladder, or uterus.   In operating on the extremities, anæsthesia will be more promptly induced if the current of blood be stopped by compression of the main artery of the limb.   Pure rectified ether thus employed is entirely free from irritating qualities, and possesses the additional advantage of not causing any painful reaction.   It is applicable to the same class of cases as rhigoline.

PART SECOND.

SPECIAL SURGERY;

OR,

DISEASES AND INJURIES

OF

PARTICULAR ORGANS, TEXTURES, AND REGIONS.

PART SECOND.

SPECIAL SURGERY; OR, DISEASES AND INJURIES OF PARTICULAR ORGANS, TEXTURES, AND REGIONS.

CHAPTER I.

DISEASES AND INJURIES OF THE SKIN AND CONNECTIVE TISSUE.

SECT. I.—ERYSIPELAS.

ERYSIPELAS is not only a frequent but a most formidable disease. Produced by various causes, both local and constitutional, it may exist as a primary affection, or occur as a complication of other lesions, modifying their character, interfering with their evolution, and even, at times, entirely supplanting them. Although most common in the skin and connective tissue, it is liable to attack various other structures, particularly the mucous and serous. By dermatologists it is usually ranked among the exanthematous diseases, on account of the discoloration which forms so striking a feature in its symptomatology. The term by which it is generally designated is a Greek one, signifying a tendency to spread.

The most common division of erysipelas is into the simple, phlegmonous, and œdematous. The terms idiopathic and traumatic are also used, according as the disease is dependent upon some constitutional vice, or upon external injury. Attempts have been made to draw a distinction between erysipelas and what has been so graphically described by Dr. Duncan, of Edinburgh, under the name of " Diffuse Inflammation of the Cellular Texture," now more generally known as " cellulitis." No one, however, who has carefully studied the subject, can fail to perceive that the two affections are in reality identical, the only difference between them being that in the one case the morbid action begins in the skin, and in the other in the connective tissue, both structures being always more or less seriously involved during the progress of the disease. The causes, march, symptoms, morbid changes, termination, and mode of treatment are precisely alike in the two cases. Hence I agree perfectly with the late Mr. Thomas Nunneley, of Leeds, who has so critically and ably examined the subject in his excellent Treatise on Erysipelas, published in 1841, that such a distinction is as unnecessary as it is unscientific.

Erysipelas occurs at all periods of life, and in both sexes; but of the two forms of the disease, the idiopathic is most common in women, while the traumatic is most frequently met with in men, simply because the latter are more liable than the former to all kinds of injury and exposure. What influence, if any, temperament exerts upon its production, has not been determined. Nervous, irritable, and intemperate persons are particularly subject to it. The greatest number of cases, at least in this country, occur in the latter part of autumn and early in the spring. Locality, doubtless, exerts an important influence in its causation. Thus, it is well known that it is particularly liable to occur in the narrow, crowded, and filthy streets of large cities, in the confined and ill-ventilated wards of hospitals, and in marshy, malarial districts. The effect of occupation in producing erysipelas has not been ascertained; but there is no question that cooks, blacksmiths, foundry-men, and persons habitually exposed to dry heat, are particularly obnoxious to its attacks.

No region of the body is exempt from its affection, though some are more liable to it than others. The idiopathic form is most frequent in the face, scalp, neck, and trunk, while the traumatic appears to be most common in the extremities, particularly the inferior. The eyelids, nose, and forehead are especially prone to be assailed. Old, de-

crepit subjects, and persons worn out by intemperance and disease, often suffer from erysipelas of the scrotum, vulva, feet, and legs. Injuries of the scalp, tendons, and aponeuroses frequently give rise to the disease, and are liable, in consequence, to be followed in many cases, by the worst results.

Erysipelas occasionally assumes an *epidemic* type. Hippocrates had already observed this fact. During the middle ages a gangrenous erysipelas repeatedly ravaged France, where, from its excessive violence, the disease was called the plague of fire. Erysipelas has frequently prevailed as an endemic in camps, barracks, hospitals, and prisons. In modern times it has been observed in both of these forms in various localities. Dr. Gregory expresses the belief that there is not a single hospital in London which has not occasionally been visited by the endemic variety of the disease. At St. George's Hospital, in that city, he repeatedly saw erysipelas so prevalent that all important surgical operations were obliged to be postponed for fear of the supervention of the malady. The inmates of the old Hôtel-Dieu of Paris were frequently assailed in this way, and the mortality thence arising is said to have been very great. Calmiel states that there are periods when erysipelas prevails so extensively in the lunatic asylums of the French metropolis that the physicians of those institutions are compelled to suspend all treatment by counterirritants, as blisters, setons, issues, and moxas, on account of its great liability to be followed by an outbreak of this affection. Velpeau describes an epidemic erysipelas which prevailed at La Pitié in 1831. In 1844, '5, and '6, the disease was so common in the Louisville Hospital, and also throughout the city of Louisville, where I then resided, that I was obliged, on numerous occasions, to postpone the performance of all operations in which delay was admissible, for fear of giving rise to it. Such was the tendency, at that period, to its occurrence, that the most trivial incision, puncture, or scratch was almost sure to be followed by an attack. For a long time we were obliged, in consequence of this proclivity, to refrain from the use of blisters, leeches, venesection, setons, and issues. Chancroids, buboes, and common ulcers were often invaded in a similar manner. But the epidemic was not confined to that city; it prevailed more or less extensively in different sections of the Union, and carried off an immense number of all classes of people. In many localities there was a marked connection between the affection and puerperal peritonitis, the latter of which proved very fatal.

The epidemic here referred to first showed itself, in 1842, in Canada, whence it rapidly spread to Vermont and New Hampshire. The disease usually began in the throat and fauces, or simultaneously in these parts and upon the cranio-facial region, in the form of a deep red, glossy, œdematous swelling, which gradually extended until it involved the whole of the neighboring structures, the countenance being generally distorted in the most hideous manner, so that the patient could hardly be recognized even by his most intimate acquaintances. The tongue, uvula, and tonsils were enormously swollen, deglutition and breathing were extremely difficult, and death was often produced by suffocation. Delirium and excessive prostration were early and prominent symptoms, and many of the cases perished within the first five days. The disease remained generally confined to the parts originally affected. If the patient survived any length of time, profuse suppuration, and sometimes even extensive sloughing, occurred; abscesses formed in various regions of the body; and, after much suffering, the patient either recovered, or died from exhaustion. In some of the persons whom I attended there was extensive ulceration of the tonsils and arches of the palate, and, in several, complete destruction of the gland of one side. In one case, almost the whole of the occipital bone was stripped of pericranium. Dissection disclosed deep engorgement of the lungs, accompanied, in many cases, by inflammation of the bronchial tubes, and even of the pulmonary parenchyma, and by effusion of serum, or of serum and pus, in the pleura and arachnoid sac. The abdominal and pelvic viscera were generally sound, except in lying-in females, who usually exhibited high evidence of peritonitis, metritis, and phlebitis. In one instance, which occurred quite early in the epidemic, the immediate cause of death was a large metastatic abscess in the left lung, the erysipelas being seated in the corresponding leg.

The disease thus briefly described was generally known in the West under the name of "black tongue," "swelled head," or "erysipelatous fever." It seldom attacked any one under fifteen years, but from that period up it was indiscriminate in its selection of subjects. Females seemed to suffer quite as frequently as men. The poor and the intemperate were its most common victims.

If a *dissection* be made of a limb in an erysipelatous state, it will be found to exhibit various appearances, according to the amount of the diseased action. In the milder grades, there will merely be some degree of induration of the skin, unusual distension of

the vessels, and slight effusion of serum, or of serum and lymph, in the subjacent connective tissue. In the phlegmonous variety, there is generally extensive infiltration of the ordinary inflammatory products; the lymph has a spoiled and unnatural appearance, looking like lard or a mixture of flour and water; abscesses exist in various situations; the connective tissue is converted into grayish or ash-colored sloughs; and the muscles are extensively separated from each other. In a case which I attended in 1846, during the prevalence of epidemic erysipelas, the abscess reached from the hip to the ankle, extensively detaching the muscles from each other and from the bones, which might have been lifted almost bodily from the diseased mass, so completely were they severed from their connections. Pure blood is sometimes extravasated in considerable quantity; and the matter, which varies much in its color and consistence, is often excessively offensive. Metastatic abscesses are occasionally found in the internal viscera, and effusions in the serous cavities. Endocarditis with granular degeneration is not unfrequently observed, and in the more severe and protracted cases, the heart is more or less flabby. Organic disease of the kidneys is often met with, manifesting itself in the lighter forms of nephritis. Evidences of inflammation of the brain and its membranes are occasionally present when the erysipelas occupies the scalp.

The question as to the *contagiousness* of this disease is not fully settled. Much may be said both against and in favor of such a view. My own opinion, founded upon considerable experience, is that the affection, at times, possesses such a character. It is very well known that it is inoculable. Thus, a sponge impregnated with the matter of an erysipelatous sore will very readily communicate the disease to an ulcer or an abraded surface in a sound person, and the same thing is true of poultices, ointments, and other dressings. Facts showing that the nurses and friends of individuals affected with erysipelas often contract the disease are of frequent occurrence. In this way whole families are sometimes cut down. A gentleman, in 1852, lost his only son by this disease. A cousin and a female acquaintance who attended him soon became ill with it, and both died; it then spread to other members of the family, and produced most serious ravages before it was finally arrested. In 1846, when erysipelas reigned as an epidemic in Kentucky, a man was received into the Louisville Hospital with an ulcerated bubo, and about the same time his mistress was also admitted with the prevailing distemper. In consequence of an inability to obtain a female nurse, the man was permitted to attend upon her in that capacity. He soon cohabited with her; in a few days he became excessively ill, the sore in the groin assumed an erysipelatous aspect, and in less than a week from the time of his admission he died from the effects of the malady. In the wards of hospitals erysipelas often spreads from one person to another; and in private practice it is occasionally carried by the physician from one house to another. It is in this manner that the parturient female not unfrequently becomes the victim of the accoucheur.

Causes.—The causes of erysipelas are too numerous and diversified to admit of any very definite specification. As a rule, it may be assumed that whatever has a tendency to disorder the digestive, hepatic, or, in short, any other important function, is capable of producing the disease. So true is this that there is seldom, if ever, a case of the complaint in which such derangement does not play a more or less conspicuous part. The fact is important, as leading to valuable therapeutic considerations. Certain articles of diet either predispose to or induce the malady. Thus, there are some persons who cannot eat shell-fish or some particular kinds of fruit, as strawberries, nuts, and similar substances, without suffering from an attack. The retention of vitiated secretions and undigested food in the alimentary canal often leads to similar results. Derangement of the uterine functions, suppression of the cutaneous perspiration, great mental excitement, the habitual use of ardent spirit, loss of sleep, hard study, inordinate sexual indulgence, and, in short, whatever has a tendency to weaken the corporeal faculties, may be enumerated as so many causes of the disease. A vitiated state of the atmosphere, such as is witnessed in hospitals and other charities, often powerfully predisposes to its attacks, as well as to its continuance. Some of the worst cases of this disease that I have ever seen came on during the progress of albuminuria. Indeed, there is reason to believe that organic disease of the kidney is a not unfrequent cause of erysipelas, especially after violent injuries, severe shock, or great loss of blood.

Erysipelas frequently supervenes upon wounds, both accidental and artificial, interfering with the healing process, and, at times, seriously compromising both the part and the system. The period at which this occurs varies from twenty-four hours to several days, according to the nature and extent of the lesion, the presence or absence of complications, the habits of the patient, the condition of the system, and the state of the atmosphere.

Lacerated, punctured, gunshot, railway, and poisoned wounds are much more liable to be assailed in this manner than incised wounds, although the latter are by no means exempt from it, especially if they involve the scalp, hands, or feet, or if they affect old, intemperate, or debilitated individuals. In a case reported to me by Dr. J. P. Miller, of Kentucky, a severe attack of erysipelas of the eye supervened upon the bite of the common house-fly; and in 1847, in this city, a woman from a similar occurrence lost her life, the wound having been inflicted upon the lip. I have seen destructive erysipelas of a finger produced by a wound inflicted by the fin of a fish, the prick of a needle, and the teeth of man and other animals. Indeed, a punctured wound from any cause is peculiarly prone to take on this kind of action, often followed by the most violent symptoms and the most serious consequences.

When the disease is epidemic, it often shows itself within a very short time after the receipt of an injury, however slight or insignificant. Under such circumstances, indeed, I have, as already stated, known it to follow upon the most trivial wound, scratch, or puncture, as a leech-bite, venesection, vaccination, or the application of a blister. Fractures, dislocations, sprains, contusions, and various other injuries not unfrequently give rise to it. Ulcers, whether common or specific, are often invaded by it, especially when the patients are of a broken constitution. Lying-in females are, in certain conditions of the atmosphere, particularly prone to suffer from erysipelas of the uterus and pelvic veins.

Finally, erysipelas frequently engrafts itself upon other diseases. During the winter of 1857, when the malady was endemic in this city, a number of instances occurred where it supervened upon measles, scarlatina, and typhoid fever. During the epidemic of erysipelas in Louisville, in 1844, '5, '6, every case of disease that was admitted into the public hospital of that city received its peculiar impress, and wore for a time its peculiar livery. When the affection was raging at its fullest height in the institution, many of the patients who were convalescing from other maladies were suddenly seized with diarrhœa, pneumonia, and bronchitis, over which the usual remedies exercised no control, and which generally proved fatal in a few days after the attack.

When erysipelas supervenes upon wounds, its approach is usually denoted by an arrest of the adhesive process, by a tensive, burning sensation in the affected part, by a discharge of thin, sanious matter, or an entire suspension of secretion, and by an œdematous appearance of the surrounding structures. Finally, the characteristic blush occurs, and, gradually diffusing itself, often spreads over a considerable extent of surface.

When erysipelas seizes upon ulcers, as it may at any time, whether they are benign or malignant, simple or specific, the local symptoms closely resemble those which characterize the complaint when it follows upon wounds and contusions. The granulations, if any exist, assume a pale, glossy, unhealthy aspect, the pus is replaced by a thin, ichorous fluid, the part is rendered uncommonly painful, and the edges of the sore, along with the adjacent surface, exhibit a reddish, œdematous appearance. In chancroids and dissection wounds the presence of erysipelas is indicated by reddish, tender lines, formed by the superficial lymphatic vessels, generally extending as high up as the neighboring glands, which, in turn, become swollen and exquisitely painful. The morbid action may, in both cases, be simple or phlegmonous, and is almost always dependent upon derangement of the digestive organs, or the suppression of some habitual discharge.

Erysipelas, consequent upon wounds, contusions, fractures, and dislocations, generally manifests itself within the first forty-eight hours after the receipt of the injury, and often spreads very rapidly over a large extent of surface, as the greater portion of a limb, one side of the trunk, or the whole scalp and face. The accident is particularly liable to supervene upon the more severe forms of these lesions, and is always to be viewed with distrust, as it not unfrequently compromises the patient's recovery. Erysipelas of the scalp, caused by wounds and fractures of the skull, generally appears from the second to the third day, and often proves dangerous by its extension to the brain and its envelops, through the intervascular communications between the pericranium and the dura mater. Such cases always demand the greatest vigilance on the part of the practitioner.

Varieties.—In simple erysipelas, described sometimes as the erythematous form, the disease is confined exclusively to the skin. It manifests itself in a bright, vivid, almost scarlet discoloration of the surface, a pungent, smarting, or burning pain, and a sense of stiffness, with, perhaps, here and there a little vesicle, not larger than the head of a pin, and filled with a serous fluid. The swelling is very slight, and, unless the extent of disease is considerable, there is no particular constitutional disturbance. The attack is usually of short duration, and the subsidence of the local disease is always followed by a furfuraceous desquamation of the epidermis.

Phlegmonous erysipelas is a much more serious lesion than the simple, all the symptoms existing in a higher degree, and the disease often terminating in extensive suppuration, abscess, and even gangrene. The discoloration varies from scarlet to deep purple; there is extensive swelling; vesication soon arises; and the pain is of a violent, burning, tensive, and throbbing character, the part feeling heavy, stiff, numb, and as if it were on fire. The inflammation extends deeply among the different tissues, affecting the skin, connective tissue, muscle, and, in short, everything that comes in its way. As it progresses, suppuration takes place, leading to the formation of extensive abscesses, and the destruction of large portions of the connective and adipose tissues. If the morbid action is very intense, mortification will be apt to arise, its approach being indicated by the development of large blebs, filled with bloody, yellowish, or muddy serum, and by a dark, livid, brownish, or ash-colored appearance of the skin. The constitution sympathizes early and deeply, the symptoms being at first of a sthenic character, but soon becoming typhoid.

The *œdematous* variety depends entirely upon accidental causes, its name being derived from the circumstance of the parts being infiltrated with serosity, and, consequently, pitting under pressure. It is most common in the eyelids, scrotum, prepuce, vulva, and inferior extremities, in persons who are debilitated by previous disease, or who naturally possess a feeble constitution. The swelling is often considerable, but the discoloration and pain are comparatively trivial. The diseased surface has a glossy, distended appearance, and retains the mark of the finger for some time after it has been withdrawn. The inflammation is attended by constitutional disorder, generally of a typhoid character, and is apt to terminate in mortification rather than in abscess, although the latter is often present in the more severe cases.

Erratic erysipelas is characterized, as the name imports, by a disposition to extend from one point to another; it is most commonly met with on the face and forehead, from which it frequently spreads, on the one hand, to the hairy scalp, and, on the other, to the neck and ears. In a case of this form of erysipelas, under my charge, the attack, commencing on the left nates, finally extended over the whole trunk. The disease is generally superficial, and is characterized by an erythematous appearance of the surface, with pungent pain, but little swelling.

Although erysipelas, as previously stated, is generally a disease of the skin, or of the skin and subcutaneous connective tissue, it not unfrequently occurs in other structures, more particularly in the mucous and serous, the joints, the veins, and the absorbent vessels, either as an idiopathic or traumatic affection. Of the mucous membranes the parts most liable to suffer are the tonsils, the palate, the uvula, the pharynx, and the larynx, the disease existing sometimes independently, but more commonly in conjunction with erysipelas of the skin. The affected structures are of a crimson or bright scarlet color, œdematous, incrusted with patches of lymph, exquisitely painful, and attended with great functional disturbance, and high constitutional excitement, rapidly passing into a low, typhoid condition. The breath is excessively fetid, and of a peculiarly contagious character, the attendants not unfrequently becoming inoculated by it.

Erysipelas of the larynx is met with chiefly in the upper portion of the tube, at and immediately below the rima of the glottis, constituting what, since the time of Bayle, has been known as œdema of the windpipe, the parts here being supplied with a considerable quantity of loose connective tissue, whereas lower down the mucous membrane is so firmly adherent as to render distension by inflammatory deposits impossible. The disease, which will receive special attention in the chapter on affections of the air-passages, is particularly dangerous on account of the mechanical impediment which it causes in respiration, as well as the great depression of the vital powers which, usually even at an early stage, attends it. The attack is frequently secondary, or a consequence of an extension of erysipelas from the fauces.

Erysipelas of the serous membranes is most common in the arachnoid and the peritoneum; in the former as a result of injuries of the scalp and cranial bones, and in the latter of the effects of strangulated hernia and contusions of the pelvis and abdomen. Lying-in females not unfrequently suffer from a bad form of erysipelas, the disease sometimes prevailing as an endemic, especially in the crowded wards of hospitals. Attacks of this kind generally begin in the veins of the uterus or in those of the broad ligaments, from which the disease extends to the subserous connective tissue and thence to the peritoneum, the symptoms which follow it being strongly denotive of pyemia, attended with a low, typhoid condition of the system, soon terminating in death. The secretions that are

poured out in this form of erysipelas are commonly aplastic, very copious, highly inoculable, and liable to cause dangerous, if not fatal, dissection wounds in making post-mortem examinations.

Erysipelas of the joints is usually associated with the disease as it occurs in other parts of the body, the most common exciting causes being punctured and gunshot wounds, contusions, and suppression of the cutaneous perspiration. In pyemia the larger joints often suffer more or less severely from this cause, the lining membrane being incrusted with aplastic lymph, and their interior distended with sero-purulent fluid, generally of a highly acrid character.

The veins and lymphatic vessels are often attacked with erysipelas, sometimes primarily, but most frequently secondarily. The most common exciting causes are injuries, as wounds and contusions, surgical operations, as the ligation of varicose veins of the extremities, and violence sustained by the veins of the uterus during parturition. Punctured wounds, more especially of the foot and hand, are very liable to give rise to erysipelas of the absorbent vessels.

Erysipelas sometimes occurs in new-born infants, most commonly in lying-in hospitals, the parts most liable to suffer being the genital organs and the abdomen about the region of the umbilicus. It generally comes on within a few days after birth, and often spreads with frightful rapidity, involving a great extent of surface within a few hours from its first manifestation. Occasionally an instance of congenital erysipelas has been noticed. Want of cleanliness and a vitiated state of the atmosphere are the most common exciting causes of the disease. Inflammation of the umbilical vein is probably occasionally concerned in its production. In the worst forms of infantile erysipelas the affected parts are of a dark red, purple, or livid color, greatly distended, and of extraordinary firmness. A swollen, œdematous condition is sufficiently common when the disease is seated in regions of the body largely supplied with loose connective tissue.

Constitutional Symptoms.—Whatever form it may assume, erysipelas is usually preceded by symptoms denotive of general indisposition, such as a feeling of malaise, or discomfort, creeping, chilly sensations, lassitude, pain in the head and limbs, impaired appetite, and an indisposition to exertion. After continuing in this state for a period varying from twenty-four to thirty-six hours, the disease declares itself in a more open manner. The patient is now suddenly seized with shivering, or violent rigors, followed by, or alternating with, excessive heat, and accompanied by severe cephalalgia, nausea, intense thirst, restlessness, and a great sense of muscular prostration. The tongue is dry and coated, the skin hot, the pulse strong and frequent, the urine high-colored and scanty, and, if the temperature rise to or above 103°, almost invariably albuminous. Systolic murmurs are not uncommon, especially in delapidated or anemic subjects. As the disease progresses, the system becomes more and more exhausted, the mind wanders, and the case soon assumes a typhoid character. Or, typhoid symptoms may be present almost from the very commencement, especially if the patient is old, decrepit, or depressed by previous suffering. In the milder forms of erysipelas, there is often very little, if any, constitutional disturbance.

If blood be drawn during the progress of the disease, it will generally be found to exhibit a sizy appearance. Sometimes it is deeply buffed, and even cupped. What internal or intrinsic changes the mass of blood undergoes in this affection has not been satisfactorily determined. Enough, however, is known to show that in the more severe forms of the affection there is generally a marked increase of fibrin and white corpuscles.

Diagnosis.—Erysipelas is generally so well marked as to render it impossible to confound it with any other disease. The only form which is liable to cause error of diagnosis is the simple, which may be mistaken for erythema, which it certainly very much resembles. The signs of discrimination are, the peculiar character of the pain, which is sharp, pungent, and smarting in erysipelas, and almost absent in erythema; the deeper redness in the former than in the latter, and the tendency also to the evolution of vesicles, which does not exist in erythema.

Pathology.—The pathology of erysipelas is still involved in obscurity. How it is induced, what is its seat, or where it originates, are points concerning which we are wholly ignorant. All that is known is that it has a peculiar predilection for the dermoid and connective tissues, the cellular elements of which, along with the emigrant leucocytes, undergo rapid and enormous proliferation, and that it is usually, if not invariably, associated with disorder of the general system, affecting, probably, both solids and fluids. So

thoroughly am I convinced of the latter fact that I do not believe it would be possible for erysipelas ever to appear in a perfectly sound individual. If this be true, then derangement of the general health, especially as displayed in a vitiated condition of the digestive organs, must be regarded as a most important element in the pathology of this affection, and one which must exert a marked influence upon our curative agents. The opportunities constantly afforded the surgeon, in cases of accidents and operations, of testing this point, peculiarly qualify him for pronouncing upon the question. These remarks do not, of course, apply to epidemic erysipelas, to which every one is more or less liable, but to the ordinary form, the development of which, as is well known, is always so much influenced by intrinsic and extraneous circumstances, as the health and habits of the patient, his residence, the nature of his diet, and the state of his mind. When a person is intemperate, breathes a foul air, eats bad food, or has a troubled mind, the most trivial injury, as the merest prick of the finger, is often followed by a fatal attack of the disease, whereas another, although severely hurt but enjoying better health, may, perhaps, escape entirely, or suffer only in a slight degree. The surgeon, aware of this circumstance, constantly acts upon it in practice, making it a rule never to perform any serious operation until he has put his patient in a proper condition for it by the rectification of his secretions and the improvement of his general health.

Erysipelas has frequently been regarded as consisting essentially in a bad form of capillary phlebitis, it being alleged that the smaller veins are generally found to be involved in the disease, as is shown by the inflamed condition of their coats, and by the existence in their interior of various kinds of substances, as lymph, pus, and coagulated blood. Such changes undoubtedly occur, to a greater or less extent, in all severe cases of the malady ; but they occur, not as a cause, but as a consequence, of the morbid action. Other pathologists, again, consider erysipelas as being essentially an affection of the lymphatics, or of these vessels and of the veins. Finally, there is another class who look upon it as being altogether, from first to last, a blood disease, or, in other words, a species of toxemia. All these views, however, are merely so many conjectures, their truth or falsity not being fully established.

Prognosis.—The prognosis of erysipelas is greatly influenced by the character, extent, and seat of the morbid action, by the age and habits of the patient, and by the absence or presence of complications. Phlegmonous erysipelas is generally more dangerous than the simple or œdematous, as it is more liable to end in extensive suppuration, gangrene, and metastatic abscesses. A simple erysipelas, however, if of great extent, is hardly less dangerous to life than a phlegmonous one, the shock to the nervous system being nearly as severe as in a superficial but extensive burn, which often kills on this account. The disease is particularly to be dreaded when it attacks the scalp, from its liability to extend to the brain. For a similar reason erysipelas of the orbit is often a dangerous affection. Infants, young children, old persons, and the habitually intemperate bear up badly under it. Erysipelas occurring during the progress of other affections, as measles, scarlatina, and typhoid fever, is generally fraught with danger. An epidemic erysipelas is always more destructive than a sporadic one, as it is sure, under such circumstances, to impress itself with peculiar force upon the constitution. Traumatic erysipelas often proves fatal in a surprisingly short time, as in the case of a young butcher, who died under my care in less than three days from a violent attack of this disease of the hand and arm, brought on by a punctured wound inflicted by a hook used for hanging up meat.

Erysipelas occasionally manifests a remarkably relapsing tendency, the disease, after having disappeared from the part originally affected, fastening itself soon after upon some other part. In this way it may linger in the system for weeks or even months, each successive attack being, perhaps, more severe than the preceding one. Such outbreaks are generally characterized by a high degree of temperature.

Treatment.—As erysipelas is developed by such a variety of circumstances, it necessarily demands a corresponding variety of treatment. Experience long ago showed that remedies which afford relief in one case are productive of no benefit in another, and, hence, it is all-important, in every instance, that the curative measures should, if possible, be based upon a correct appreciation of the nature of the exciting causes.

The most important constitutional remedies are bloodletting, emetics, purgatives, diaphoretics, mercurials, anodynes, and stimulants.

General *bloodletting* is rarely necessary ; in fact, in most cases, it proves mischievous, by augmenting the debility of the system, already, perhaps, greatly depressed by the violence of the morbid action. The circumstances which, in my judgment, render a resort to the lancet proper in this complaint are, first, a strong, full, and frequent pulse ;

secondly, a robust and vigorous state of the system; thirdly, excessive pain and tension of the parts; and, lastly, the involvement, threatened or actual, of important internal organs, as the brain, lungs, and throat. The amount of blood to be abstracted must depend upon the effects which the operation exerts upon the system. One moderately copious bleeding, performed early in the disease, will usually be sufficient, and will answer a much better purpose than two or three small ones. Venesection, should, as a rule, be avoided in epidemic erysipelas, and in old, sickly, and intemperate persons. In the epidemic erysipelas which prevailed so extensively thirty-five years ago in various sections of the United States, the abstraction of blood was generally borne very badly, and many lives were lost by its injudicious employment. In the Louisville Hospital not a single patient recovered that was bled for this disease. In erysipelas supervening upon capital operations and severe accidents, as compound fractures and dislocations, wounds, and contusions, proper allowance must be made for the effects of shock, the loss of blood, and the resulting suppurative discharges. Children affected with erysipelas rarely, if ever, require bleeding in any form.

Great contrariety of opinion has prevailed among writers respecting the employment of *emetics* in this disorder, some having pointedly condemned them, while others have expressed themselves most warmly in their favor. In the hands of Desault and his disciples the greatest benefit seems to have attended their exhibition. The probability is that here, as elsewhere, in similar cases, the truth lies between the two extremes; for it can hardly be supposed that a class of remedies of such acknowledged potency in many cutaneous affections should be altogether useless in erysipelas. The cases in which, according to my observation, emetics are mainly indicated are those in which there is marked biliary derangement, along with nausea, loathing of food, headache, pain in the back and limbs, great restlessness, and dryness of the surface. These symptoms, so distressing to the poor sufferer, are often promptly relieved by full emesis, excited by ipecacuanha and tartar emetic, ipecacuanha alone, or salt and mustard, and encouraged by the free use of tepid drinks. In protracted cases, and in the erratic form of the malady, attended with derangement of the digestive organs, gentle emetics often operate like a charm in breaking up the chain of morbid action.

Great stress has always been very justly placed upon the use of *purgatives* in the treatment of erysipelas; and when it is remembered that this disease is often directly dependent upon an overloaded state of the bowels, the presence of irritating ingesta, and the suppression of the secretions of the digestive organs, it is not difficult to discover the reason for the practice. Indeed, it would be hard to find a case in which it would be altogether safe to dispense with them. They are more especially valuable in the earlier stages of the complaint and in strong, robust subjects. In the weak and delicate they must be used with the greatest possible care, lest they induce premature exhaustion. The articles which are mainly relied upon are calomel, rhubarb, and compound extract of colocynth, variously combined, and given in sufficient quantity to produce two or three free and consistent motions. Sometimes the addition of a little tartar emetic or ipecacuanha proves beneficial, especially when there is an arid state of the skin and mouth; while occasionally they may be advantageously replaced by others, as castor oil and spirit of turpentine, castor oil alone, senna, or Rochelle salt. When nausea and headache exist, along with a highly coated tongue, the best cathartic generally is calomel and ipecacuanha, in the proportion of about ten grains of the former to two of the latter, followed, if necessary, in six or eight hours, by a stimulating enema, or some mild laxative. When the bowels have been thoroughly evacuated, none but the most gentle aperients should be employed, as blue mass and rhubarb, Seidlitz powder, or colocynth and hyoscyamus.

Diaphoretics are of the first importance in the treatment of this affection, as there are few cases in which the cutaneous function is not more or less interrupted, perverted, or suspended. After proper depletion, gentle evacuation of the bowels, and the restoration of the secretions of the digestive organs, the administration of medicines calculated to act upon the skin often proves highly serviceable. Among the best of this group of articles are Dover's powder and the salts of antimony and morphia, aided by tepid sponging, or, when the patient's strength admits of it, the warm bath. In children and debilitated persons, the neutral mixture and wine of ipecacuanha may be advantageously resorted to. Aconite, in doses of three drops of the tincture, every two, three, or four hours, generally answers an excellent purpose, especially when there is a hot and arid condition of the surface, with inordinate excitement of the heart. The same is true of veratrum viride.

Anodynes are required to allay pain and induce sleep. When the disease occupies an unusual extent of surface, the system is very much in the condition of that of a person

laboring under a severe burn or scald, and requires, at a very early stage of the complaint, the employment of soothing measures. The remedy, commonly one of the salts of morphia, is administered either by itself, or in union with other articles, especially diaphoretics, in quantities proportioned to the exgencies of the case. As a general rule, the object is best attained by a full dose, repeated twice in the twenty-four hours. To an adult, laboring under great pain and restlessness, provided there is no cephalic trouble, not less than half a grain of morphia should be given at a time. Thus administered, the effects of the remedy are much more decided and beneficial than when it is exhibited in smaller quantities. Delirium, or cerebral disorder, does not necessarily contraindicate the use of anodynes; on the contrary, persons so affected are often greatly benefited by their judicious exhibition. To no class of patients is this remark more applicable than to habitual inebriates, and individuals worn out by previous disease, loss of blood, protracted drainage of the system, or constitutional irritation. Such persons absolutely require at an early period, and in every stage of the malady, the use of anodynes in large doses, in order to prevent exhaustion, and afford time and opportunity for the more efficient action of other remedies. Belladonna, in the form of the extract, is very serviceable in cases of idiopathic erysipelas, and especially the facial variety. When there is much febrile excitement the remedy should be combined with depressants, but when there is much depression it should be administered with quinine.

Mercurials are sometimes useful. They are particularly valuable in the erratic form of erysipelas, and when there is a tendency in the disease to linger in the system, after its principal force has been expended. In such cases they occasionally act like a charm, even when they are not carried to the extent of slight ptyalism, which, however, is often necessary, before the disorder finally relinquishes its grasp. During the epidemic erysipelas which prevailed in Louisville and its vicinity in 1844, '5 and '6, I treated a number of cases upon this plan with the most happy results. Mercury should be most scrupulously avoided in erysipelas attended with a low, typhoid state of the system in old, worn-out subjects, and in persons exhausted by intemperance and dissipation. The best form of exhibition, when the remedy is indicated, is calomel with a small quantity of opium and ipecacuanha, or Dover's powder, to restrain its action on the bowels and allay nervous irritation. In urgent cases two grains of the mineral may be given to an adult every four, six, or eight hours, combined with half a grain of the anodyne. When a less rapid impression is desired, blue mass, iodide of mercury, or the gray powder may be used. In whatever form or manner the remedy be given, its effects should never be carried beyond the limits of the slightest possible ptyalism.

The late Professor John K. Mitchell derived, as he informed me, more benefit in this disease, from the use of *iodide of potassium* than from any other remedy. His plan was, after gentle alvine evacuation, to begin at once with the article, giving it, largely diluted with water, every two or three hours, in doses of five to ten grains, until the attack was arrested, as it usually was in a few days. In the few trials which I have made of this remedy, I have witnessed no material benefit, and in several cases I was obliged to suspend its use at an early period, on account of its nauseating effects.

Stimulants and tonics are imperatively required when there is a tendency to prostration, as indicated by the hard, dry, and brownish tongue, the sordes on the teeth, the small, feeble, and frequent pulse, the twitching of the muscles, the coolness of the surface, and the copious sweats, with more or less delirium. The most reliable articles for this purpose are quinine and iron, in the form of the tincture of the chloride, a scruple of the former being dissolved in an ounce of the latter, and the mixture given in doses of fifteen to thirty drops every two, three, or four hours. When this combination disagrees with the stomach, the articles may be employed separately. In the malarial form of the disease, a not infrequent complication in various sections of the United States, quinine, in large doses, is an indispensable remedy and cannot be administered too soon. It also is particularly reliable when there is a relapsing tendency in the disease, and may then generally be advantageously combined with iron and mercury. The treatment should be aided by the liberal use of brandy, milk punch, wine, ale, or porter, and a generous diet.

Throughout the whole treatment, the greatest attention should be paid to the ventilation and temperature of the patient's apartment; the body and bed clothes should be daily changed, and the cutaneous surface should be frequently sponged with tepid salt water, or some slightly alkaline solution. As disinfectants, free use is made of the chlorides, Labarraque's solution, or permanganate of potassium. As soon as his strength admits of it, the patient should take gentle exercise in the open air, and change his sleeping apartment.

Although *topical remedies* in the treatment of this affection are to be regarded simply

as auxiliary agents, there are few cases in which, if properly employed, they are not of signal service. The list is a very large and varied one, embracing applications of the most opposite character, as warm and cold, dry and moist, astringent and relaxing, stimulating, vesicant, and anodyne.

Leeching is indicated when the patient is young and plethoric, or the disease is in its gravescent stage, and making rapid strides. The fact that the operation is occasionally followed by erysipelas does not, in my judgment, prove that it may not at times be beneficial. It is only in rare cases, and in peculiar conditions of the system, as when the patient is of a very irritable habit, or when the leeches are sickly, that such a result is at all likely to occur. Against such a contingency the judicious practitioner will, of course, always guard. The use of the remedy is particularly indicated in erysipelas of the throat and larynx, the scalp, eyelids, vulva, toes, and fingers. The number of leeches must vary according to circumstances, as the intensity of the morbid action and the vigor of the patient, the flow of blood being always encouraged by warm fomentations until the desired quantity is obtained.

One of the most valuable topical remedies is tincture of iodine, diluted with an equal quantity of alcohol, and laid on by means of a large camel-hair pencil, the end of a stiff feather, or a soft cloth mop, until the surface is of a yellowish, brownish, or mahogany color. The application, which should embrace a small portion of the sound skin, should be repeated at least twice, if not thrice, in the twenty-four hours. In the milder grades of erysipelas a single application occasionally suffices for a cure, while in the more aggravated a long continuance of the remedy may be required. Iodine, employed in the early stage of the disease, generally promptly relieves pain and tension, rapidly promotes the removal of effused fluids, and greatly assists in checking morbid action. Used very freely, it occasionally vesicates, and is thus instrumental in unloading the cutaneous capillaries. Doubtless, it also acts advantageously upon the blood and its vessels, indisposing them to further effusion.

Nitrate of silver, employed either in substance, or in strong solution, as from thirty to sixty grains to the ounce of water, is another very valuable agent in the treatment of this disease. It is applied either directly to the affected surface, or a belt is drawn around it upon the healthy skin, to prevent its further spread. I commonly prefer the former method, using the solid nitrate instead of the solution, so highly recommended by Mr. Higginbottom. In order to apply this substance properly, the surface should previously be divested of all greasy and perspirable matter, otherwise it will not unite with the epidermis, and so prove, in great measure, inert. The part should then be gently moistened with soft water, when the caustic is passed firmly and efficiently over it until the whole has been thoroughly touched. Thus employed, it speedily blackens the epidermis and coagulates its albuminous matter, thereby forming an excellent defence to the delicate tissues beneath. When used more freely it generally vesicates, elevating the cuticle into tolerably large blisters. Mr. Higginbottom applies a strong solution of the nitrate of silver, consisting of three drachms of the salt to the ounce of water, with the addition of a small quantity of nitric acid. I have no experience with the remedy in this form. The probability is that nitrate of silver produces its beneficial effects very much in the same manner as tincture of iodine, changing the tone of the capillary vessels and promoting the absorption of the effused fluids, besides serving as a direct defence to the cutaneous surface by its union with the albuminous matter of the superficial layer of the skin.

The late Dr. Gilbert, of this city, often used pure creasote as a remedy in erysipelas. He applied it lightly once a day to the affected surface with a camel-hair pencil, and found it more effectual in arresting the disease than any other article. Creasote destroys the cuticle, converting it into a whitish substance, which thus defends the inflamed surface from the contact of the air.

Solutions of acetate of lead and opium, Goulard's extract, chloride of ammonium, alcohol, chloride of sodium, carbonate of potassium, sulphate of copper, and quinine, often prove highly beneficial. They are employed of varying strength, and are generally most grateful when used tepid, upon flannel cloths, frequently renewed. In warm weather, and in strong, plethoric subjects, they may be applied cold, but when this is done their effects should be sedulously watched, lest they repel the disease, or throw it upon some internal organ.

Warm water alone, at a temperature of $96°$ to $100°$, is often exceedingly efficacious, especially in erysipelas of the scalp, and in the more ordinary traumatic forms of the disease. It is applied by means of wadding or patent lint, covered with oiled silk, and frequently renewed.

The late Dr. Pitcher, of Detroit, strongly recommended, as an external application, bichloride of mercury, in the proportion of twenty grains of the salt to the ounce of alcohol. During the prevalence of the epidemic, already so frequently alluded to, I had occasion to try this treatment in a number of instances, but I did not find it to possess any advantages whatever over iodine and nitrate of silver. In nearly all the cases, upwards of twenty, the application was promptly followed by vesication and excessive pain, and, in a few, by pretty profuse ptyalism; effects which greatly aggravated the local and constitutional suffering, and rendered a speedy discontinuance of the remedy necessary. Since then I have tried the remedy in a weaker solution, but without any encouraging results.

Velpeau had great confidence in the use of sulphate of iron as a local remedy in erysipelas. The praises, however, which he lavished upon it have not been realized by practitioners generally; and I have myself been entirely disappointed with it. It may be employed in solution, in the proportion of half an ounce to two-thirds of a quart of water; or as an ointment, prepared by mixing one drachm of the impalpable powder with an ounce of lard. The former is applied by means of compresses, frequently moistened; while the latter is rubbed on freely several times in the twenty-four hours.

Dr. Holston has derived marked benefit from the local use of chloroform, brushed over the affected surface for a few minutes with a large camel-hair pencil, the parts being immediately afterwards covered with wadding, and the application repeated, if necessary, at intervals of three to four hours. Prompt relief, it is asserted, usually follows, the disease, even if extensive, often yielding in a very short time.

Bromine has been highly extolled as a local remedy in this disease, more especially by our army surgeons, by whom it was extensively employed during the late war. It is applied directly to the inflamed surface in solution, from twenty to forty drops being mixed with the ounce of water, according to the severity of the morbid action. A small quantity of bromide of potassium may sometimes be advantageously combined with it.

In the milder varieties of erysipelas I have occasionally witnessed excellent results from a liniment of equal parts of laudanum, ammonia, and olive oil, applied upon a soft, thin compress. When the skin is very delicate, the proportion of ammonia may be diminished. The common soap liniment, with the addition of a small quantity of tincture of iodine, and confined with a roller, is also a valuable remedy in simple erysipelas.

Of the various greasy substances that have been recommended in the treatment of this affection, one of the most celebrated is mercurial ointment, first advised in this complaint by Dean and Little, of Pennsylvania. A thick layer of this is spread upon cloth, and secured to the part by means of a bandage, or, what is preferable, rubbed gently but efficiently upon the diseased surface. The article has been highly lauded by Rayer and others, but my own experience has not supplied me with any facts in its favor; indeed, it is doubtful whether it possesses any advantage whatever over common lard, suet, or simple cerate. In infantile erysipelas, I have sometimes derived excellent effects from the application of the ointment of oxide of zinc. Professor Gibson speaks favorably of the use of British oil; and Dr. Coates, of this city, has successfully employed tar ointment. The cranberry poultice has long been a popular remedy in this country, its virtues, as supposed by Dr. Munroe Bond, of New Hampshire, probably depending upon the presence of malic acid.

Dusting the affected surface with starch, flour, arrowroot, prepared chalk, carbonate of zinc, pearl powder, and similar substances, is sometimes useful in the more simple varieties of erysipelas, but entirely unavailing when the disease is deepseated, or of a phlegmonous character. In the former, they occasionally prove beneficial by relieving the disagreeable itching, smarting, or burning sensation of the skin. In superficial erysipelas, I have sometimes obtained advantage from painting the inflamed surface with collodion, the application appearing to impart a healthful stimulus to the cutaneous capillaries, to incite the absorbents, and to contract the skin and subjacent connective tissue.

The treatment of erysipelas by blisters, is peculiarly valuable in the phlegmonous form of the disease, and in erysipelas supervening upon wounds, ulcers, chancroids, buboes, and abrasions. The proper plan is to apply the vesicant directly to the inflamed surface, and to retain it until it has raised the epidermis most thoroughly. The serum is then evacuated with a needle, and the part dressed with a light starch, elm, or linseed poultice.

In children, and in old or sickly persons, the blister must be removed at an early period, otherwise serious mischief may ensue.

The subcutaneous injection of a three per cent. solution of carbolic acid, first suggested by Professor Hueter, on account of the assumed dependence of the disease on the development of parasitic fungi in the tissues, has been abandoned.

When the disease is accompanied by suppuration, great tension, or impending gangrene, nothing short of free incisions or punctures will answer, all other topical remedies being then of a subordinate character, as the object is to afford vent to effused fluids, as serum, lymph, pus, and blood, to relieve capillary strangulation and remove pain and tension. The practice is indicated the moment there is the slightest perceptible fluctuation, and, in violent cases, even as soon as there is considerably throbbing. By thus anticipating the suppurative process, the patient escapes much suffering, as well as loss of texture; for, if the matter is retained in the parts, its inevitable tendency is to burrow among the surrounding structures, and to contaminate the system.

To afford relief, the incisions need not be three, four, or five inches in length, as formerly recommended by Mr. Lawrence and other British surgeons. Such a course is highly cruel and reprehensible; for, independently of the pain which attends the operation, it is liable to be followed by copious hemorrhage, which, occurring at a time when the patient is perhaps ill able to bear it, must often cause serious, if not fatal mischief. A few cuts from half an inch to an inch and a half in length, and deep enough to liberate the pent-up fluids, ought to be sufficient in any case, unless it has been greatly mismanaged, or neglected. In such an event, the incisions may be multiple, being made at suitable distances from each other, and in such a manner as not to interfere with any important structures, as large vessels, nerves, or joints. If hemorrhage be unavoidable, it is to be arrested by the usual means, as compression, styptics, or ligation. The best application after the bleeding has ceased is an emollient poultice, or the warm water-dressing, medicated with acetate of lead and opium. The loss of a small quantity of blood is often of essential benefit in relieving the disease.

Punctures are more particularly useful in the œdematous forms of the disease, to evacuate the serous fluid upon which the distension, which is often a source of so much mischief, mainly depends. When suppuration or gangrene is threatening, punctures must give way to incisions. The number of punctures, and the depth to which they are carried, must vary according to circumstances. The best instrument for making them is a very narrow, sharp-pointed bistoury, introduced perpendicularly to the surface, with the necessary care to avoid important structures.

In the milder forms of erysipelas of the extremities, valuable aid may often be derived from the application of the bandage. It is particularly efficacious in the early stages of the disease, as it tends, if judiciously employed, to support the affected structures, and to prevent vesication and suppuration. The application should be made as equably as possible, and with a certain degree of firmness, its effects being carefully watched, and aided by simple or medicated lotions.

Finally, in the epidemic form of this disease, much may be accomplished by way of prophylaxis. Among the more important elements in this kind of treatment are isolation of the sick, thorough ventilation, personal cleanliness, and an abundance of good, wholesome food. These precautions are particularly necessary in hospitals, prisons, asylums, camps, barracks, and ships. When persons are crowded together, in narrow and confined situations, the air is speedily contaminated, and the disease is sure to spread with fearful rapidity and violence, especially if the body is affected with wounds, contusions, ulcers, or compound fractures. The best internal prophylactic is the tincture of chloride of iron, given in doses of twenty to thirty drops every four or six hours, either alone or in union with quinine, the latter remedy being particularly valuable when the disease is of a malarial character. Arsenic will then also be of great service.

SECT. II.—FURUNCLE OR BOIL.

A furuncle, vulgarly called a boil, is a peculiar inflammation of the skin and connective tissue. Liable to occur upon any portion of the body, excepting, perhaps, the palm of the hand and the sole of the foot, it is most common upon the face, nape of the neck, buttocks, and fingers, often forming in considerable numbers, either simultaneously or successively, although generally there is only one. Both sexes, and all periods of life, are subject to it; the young, however, suffer more frequently than the old or middle-aged. Some persons are habitually affected with boils, being seldom entirely free from them at

any time for years. Now and then they disappear for a while, and then suddenly break out again. Boils are a very common sequel of eruptive affections, as smallpox, measles, scarlatina, and typhoid fever, and, under these circumstances, they occasionally display a marked epidemic tendency. In the latter event, they are very liable to occur in association with carbuncle and whitlow. Children during dentition, and during chronic attacks of cholera, sometimes suffer excessively from this disease. I have often, in these complaints, seen the whole surface literally covered with boils, the patient experiencing great pain and prostration.

The causes of furuncle are generally inappreciable. Occasionally their formation may be traced to external violence, as a contusion, or the concussion sustained by the skin and connective tissue in riding on horseback. In the majority of cases, if not in all, it is obviously connected with a disordered state of the digestive organs, or with some derangement of the secretions. Thus, persons who labor habitually under disease of the liver, and females who are troubled with irregularity or suppression of the menses, are very prone to suffer from its attacks. Diabetes and albuminuria predispose to its occurrence. Large, painful, and obstinate boils not unfrequently follow the application of blisters, especially in young, broken-down children and elderly subjects. Cold water, used endermically for any considerable length of time, as a therapeutic agent, is liable to give rise to similar effects. On the fingers a painful form of boil occasionally has its origin in a hair follicle.

A boil consists essentially in a circumscribed inflammation of the sebaceous and sweat glands and hair follicles, eventuating in suppuration and sloughing. It usually begins as a small, hard, red pimple, which, as it proceeds, gradually assumes a conical figure, the apex being formed by the skin, and the base by the connective tissue, its volume varying from that of a currant to that of a pigeon's egg. The pain which accompanies it is, at first, of a burning, smarting character, but afterwards, especially when matter is about to be formed, it becomes throbbing and exceedingly severe. A sense of tension is also commonly present. The skin is of a dusky, reddish aspect, and exquisitely sensitive to the slightest touch. As the tumor increases, a little vesicle forms at its apex, containing a drop of serum, and indicating the point where the boil will discharge itself. When the furuncle is large, or multiple, there is usually more or less constitutional disturbance, as manifested by the want of appetite, a bad taste in the mouth, headache, chilliness, and a feeling of great uneasiness. Finally, a boil in the lower extremity, or upon the buttock, often gives rise to sympathetic enlargement of the glands of the groin, and in the upper extremity of the glands of the axilla. The period required for the disease to reach its height varies from three to eight days.

If a section be made of a boil, with a view to the examination of its structure, it will be observed to consist of a mass of dead tissue, ordinarily called a core, immersed in thick, yellowish pus, the parts around being very hard, matted together with lymph, and preternaturally vascular. The skin is also indurated, and abnormally tense, red, and injected. Occasionally the contents of the swelling are almost wholly made up of blood, or of a mixture of blood, pus, and slough. This form of boil, to which the term hematoid may be applied, is most common in elderly persons of a broken constitution, and is usually attended with much local and general distress.

It is seldom, under any circumstances, that a furuncle can be made to abort, or to terminate in resolution, its invariable tendency being to suppurate and slough. In its very incipiency, I have occasionally succeeded in arresting its course by a brisk purge, and the application of iodine, but if it has already made some progress, such an attempt will prove altogether futile. The best plan generally is at once to poultice the part, and to make an early and free incision to let out its contents. The relief experienced from the operation is always prompt and decided. The burning, throbbing pain, so constantly present, is always greatly mitigated by the use of a strong solution of carbolic acid in glycerine, applied upon a compress. If the sore is slow in healing, either from the retention of dead connective tissue, or a want of healthy action from other causes, its surface should be well touched with nitrate of silver, the same article, iodine, or a small blister being applied to the surrounding surface. In most cases the patient will be benefited by purgative medicine and light diet.

When there is a decided furuncular diathesis, as when a great number of boils exist simultaneously, or form in rapid succession, benefit may be expected from an occasional emetic, and from mercurial purgatives, with the internal use of iodide of potassium and Donovan's solution. Sometimes Fowler's solution answers a good purpose, or, what I prefer, arsenic in substance, from the tenth to the fifteenth of a grain three times a day.

In very obstinate cases slight ptyalism may be required before the disease finally yields. When boils are developed as a consequence of exhausting diseases, tonics, mineral acids, a nutritious diet, and country air are indicated. Alkalies are useful when there is acidity of the stomach and bowels. Daily bathing with salt water, or water impregnated with bicarbonate of potassium, will occasionally be serviceable, especially when there is unusual torpor of the skin.

SECT. III.—ANTHRAX OR CARBUNCLE.

The most accurate definition that can be given of a carbuncle is that it is a boil on a large scale, with the addition of gangrene, it being, like that affection, a peculiar inflammation of the cutaneous and connective tissues, not circumscribed, however, as in that disorder, but disposed to spread. Its most common seat is the posterior part of the trunk and the nape of the neck, particularly near its junction with the occiput. The gluteal and sacral regions are also liable to the disease, but it is very seldom that it occurs in the extremities. A bad form of carbuncle occasionally forms upon the chin and lower lip.

Elderly persons are most prone to carbuncle, and it is generally believed that such as are fat and indolent, or addicted to the pleasures of the table, are more frequently attacked than the lean and active. In my own practice, however, this has not been the case. On the contrary, the greatest number of instances has occurred in thin subjects, after the age of fifty, whose constitution has been broken down by long-continued intemperance, impoverished diet, deficient clothing, and mental anxiety. In London carbuncle is said to be remarkably common among the lower orders, in consequence of the enormous quantities of ale and porter which they habitually consume. The disease is more frequent in winter than in summer, and in men than in women: occasionally it displays an epidemic tendency. Carbuncle is one of the symptoms of plague. The extent of the inflammation varies from that of a dollar up to that of a large saucer, its average being about that of the palm of a small adult hand.

Of the exciting *causes* of carbuncle nothing satisfactory is known. Most commonly the outbreak of the disease is ascribed to the effects of cold, to disorder of the stomach, overeating, constipation of the bowels, loss of sleep, excessive venery, and other debilitating influences; but how far, or in what degree, these circumstances tend to favor its development it is impossible to say. I have myself long regarded the malady as essentially of a constitutional nature, resembling, in this respect, erysipelas and some other affections; and a careful study of the history of the disease certainly warrants such an interference. A long course of debauch, or indulgence in the pleasures of the table, attended with a vitiated state of the secretions, is, as is well known, highly conductive to the development of carbuncle in its worst forms. When a person has been for years in this condition, eating and drinking luxuriously, and taking hardly any exercise, the slightest exposure to cold, suddenly checking the cutaneous perspiration, would, it may easily be imagined, tend to produce the disease in a part habitually congested and enfeebled in its action. There is then not merely a bad state of the solids, but the blood also comes in for a share in the proceeding, surcharged, as it must be, with irritating materials which the solids have long been unable to throw off as recrementitious substance. Whether, however, this conjecture is correct or not, the fact is indisputable that carbuncle is rarely, if ever, of traumatic origin, or found in persons of a vigorous and healthy circulation. Cases occur in which the disease is evidently connected with, if not directly dependent upon, a diabetic condition of the system.

One of the first *symptoms* of carbuncle is generally an itching, burning, or smarting, with a sense of numbness, in a particular part of the skin, which, on examination, is found to be of a dusky, reddish color, slightly tumid, and somewhat tender on pressure. As the disease progresses, the local distress sensibly increases; the pain soon becomes throbbing and exceedingly violent, the part feeling as if it were in contact with melted lead; the surface assumes a livid hue; the swelling spreads both in circumference and in depth; and the slightest touch of the finger is intolerable. Along with these phenomena, the patient usually experiences a sense of weight and tension, which greatly adds to his suffering. The part is hard, and circumscribed, feeling like the rind of bacon, and occupying a space from the size of a dollar to that of the palm of the hand. Presently vesicles begin to form at the focus of the inflammation, containing a dirty, turbid, yellowish, or sanguinolent fluid, and generally not exceeding the diameter of a pea, although occasionally they are quite large. Upon bursting, these vesicles expose a corresponding number of openings in the true skin, giving the surface a cribriform appearance, and lead-

ing down into the connective tissue, which is already in a state of mortification. The ulcers, for so they may be called, have an irregular, ragged appearance, and are the seat of a foul, irritating discharge, which is often very abundant and exhausting.

Upon dividing the affected structures, the skin is found to be remarkably dense and firm, cutting very much like the rind of bacon. The connective tissue beneath is converted into a slough, having the appearance of a mass of wet tow, bathed with ill-looking matter, and intermixed with flakes of lymph, or matter like putty, thick pus, or curds. When the disease is of unusual extent, there may be considerable involvement of the aponeuroses and muscles, but, in general, these structures are excluded from the morbid action, the skin and subjacent connective tissue alone suffering. At the periphery of the

Fig. 239.
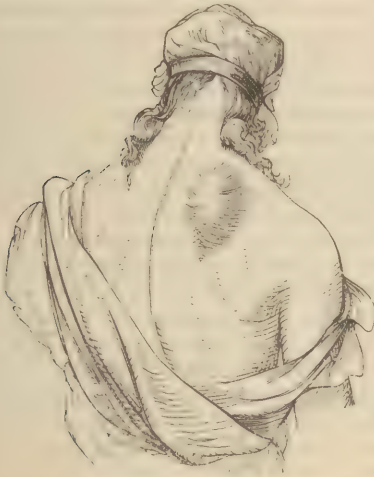
Fig. 240.

Incipient Carbuncle.

Ulcerated Carbuncle.

disease the parts are always uncommonly dense, the boundary between it and the healthy structures being established by a deposit of plastic matter, less organizable, however, than in furuncle, the morbid anatomy of which that of a carbuncle so closely resembles. The annexed sketches, figs. 239 and 240, represent this disease in its earlier and more advanced stages.

Important light has recently been thrown upon the peculiar character of some of the morbid processes of carbuncle by the beautiful researches of Dr. J. Collins Warren. In a paper published a few years ago in the Boston Medical and Surgical Journal, he described and delineated what he has called the adipose columns, and has ingeniously pointed out the part they play during the progress of the disease. The columns are particularly well-marked beneath the thick skin on the back and shoulders, where carbuncle is so often met with. The skin here, as well as in some other situations, is perforated, or nearly so, by vertical adipose columns which pass from the fatty structure beneath to the base of each downy hair follicle. Near the base of each column is given off a band of fibrous tissue from the lower borders of the cutis, which extends obliquely downward, and is inserted into the fascia below. These interlacing bands of tissue form a dense recticulum, or network, in which, in this disease, the inflammation takes its rise. As the inflammation is of that variety which rapidly leads to the development of pus, no protective barrier is formed as in abscess, and the result is that purulent infiltration takes place. The dense integument, held firmly down by the tendon-like bands of tissue referred to, yields with difficulty before the accumulating pressure, while the soft structures of the adipose columns offer but slight resistance to the pus globules, which, consequently, find their way rapidly into them, and thence directly upwards to the surface, destroying the hair follicles as they proceed, and forming at the surface a pustule of considerable size. The pus also spreads liberally from the columns into the cutis, working its way through the lymphatic meshes to the papillæ which become enormously distended, and thus give rise to the numberless minute pustules which stud the surface of the carbuncle.

This mode of the formation of pustules is very different from that usually recognized, the ordinary pustules of the skin being described as being situated in the rete mucosum.

In those portions of the skin in which this process of purulent infiltration is rendered excessive, the circulation is arrested and gangrene follows. The honey-combed crater which is thus exposed is formed by the interlacing of bands of tissue, which, tendon-like, have retained their form, if not their vitality.

In purulent infiltrations of the subcutaneous tissue of other portions of the body, the structures are less resisting; the skin is not bound down so firmly, the connective substance is of a delicate nature, and the pus spreads with great facility in a lateral direction. The skin being much thinner the adipose columns are either very short or entirely absent, and the pus finds its way to the surface, if at all, through the ordinary lymph spaces to one of the papillæ, which it distends in the manner already described.

The constitution always, even at an early period of the disease, strongly sympathizes, with the part affected. Hence, fever is generally present soon after its commencement, and sometimes, indeed, almost before there is any marked evidence of the local affection, the first symptom being often a severe rigor, followed by high vascular excitement. However this may be, the case soon assumes an asthenic type, indicative of the depraved condition of the solids and fluids so intimately concerned in the production of the disease. The tongue speedily becomes dry, hard, and brown, sordes collects upon the gums and teeth, the appetite fails, gastric derangement exists, the bowels are constipated, the urine is scanty and high-colored, the skin is hot and arid, the mind is disposed to wander, and the pulse is frequent, soft, and without force. Vomiting is often present to a considerable extent, and the alvine evacuations are generally excessively fetid.

The *diagnosis* of anthrax is sufficiently easy. Its large size, the severity of the attendant pain, and the great constitutional disturbance, will always readily distinguish it from furuncle at its commencement, and afterwards the discrimination will be still further aided by the vesicated and cribriform condition of the skin, so characteristic of carbuncle. The only affection which it at all resembles is a bedsore, but the history of the case, and the situation of the swelling, will always serve as unerring means of distinction. Malignant pustule begins as a little, circumscribed pimple, not as a diffused swelling, as in anthrax, and soon forms a large vesicle, raised above the surrounding level, and resting upon a hard, solid base, which rarely acquires much extent, at least not until the affection has made considerable progress.

The *prognosis* is variable. In general, a carbuncle may be regarded as dangerous when it is multiple, when it is very large, or when it occurs in old, fat subjects, addicted to indolence and over-feeding. The site of the disease also exerts a marked influence upon the issue of the case. Thus, a carbuncle situated on the posterior part of the head and neck will, other things being equal, be more likely to produce death than when it occupies the back, nates, or extremity, inasmuch as it is very liable to involve the brain and arachnoid membrane, causing effusion of serum and lymph. Young and comparatively healthy persons will often recover, although generally not without great suffering, whatever may be the site of the malady. In a case of an immense carbuncle of the nape of the neck, recently under my charge in a stout, fat man, sixty-two years of age, death was occasioned at the end of a fortnight by the supervention of pneumonia and erysipelas.

Treatment.—The treatment of carbuncle must be conducted with special reference to the improvement of the secretions and the support of the system. Few patients will be found to bear bleeding, active purgation, or depletion in any form. It is only when there is extraordinary plethora, combined with great vigor of constitution, that these means should be carried into effect. In all other cases, their inevitable tendency is to do harm, by bringing on premature exhaustion. Efficient purging, however, may be regarded as an indispensable remedy in almost every instance, the object being not only to get rid of irritating fecal matter, but to produce a change in the secretions. For this purpose the medicine should be given early in the disease, and a mercurial cathartic should always be preferred to any other. When marked gastric derangement exists, as indicated by nausea, headache, and pain in the limbs, no time should be lost in administering an efficient emetic, or an emeto-cathartic, as ten grains of calomel and from ten to twenty of ipecacuanha, followed by large draughts of chamomile tea, or infusion of valerian. Clearance having been effected, and function improved or restored, stimulants and tonics will come into play, exhibited warily, especially if cerebral trouble is threatened, yet efficiently if evidence of exhaustion is present, the most suitable articles being quinine, tincture of chloride of iron, and brandy, with nourishing broths. Anodynes will generally be required, in large doses, to allay pain and procure sleep. After the first few days a mild laxative, as blue mass or castor oil, is occasionally given. Determination to the brain must be promptly met by a large blister applied as near as possible to the occiput.

The best topical application, at the commencement of the disease, is the warm water-dressing, strongly medicated with acetate of lead and opium. Pencilling the surface well with tincture of iodine, and then covering it with a mixture of equal parts of olive oil, laudanum, and spirit of turpentine, sometimes produce a very soothing effect. In many cases there is nothing so promptly beneficial as a blister, large enough to include a considerable portion of the healthy skin, and retained until there is thorough vesication : it drains the vessels of serum, allays pain, and makes a salutary impression upon the general system. Leeches are commonly inadmissible, as they occasion severe pain and undue depletion. In the earlier stages of carbuncle, especially in those cases in which the morbid action is spread over a very large surface, speedy and effectual relief may often be afforded by the subcutaneous division of the indurated tissues with a delicate tenotome, introduced at four opposite points, and carried about, under the guidance of the index-finger of the left hand, in such a manner as to traverse the entire swelling. The skin itself is left intact, except at the entrance of the knife. The operation is generally followed by a good deal of bleeding. The pain and tension rapidly subside, the danger of extensive sloughing is effectually obviated, and the vital powers soon begin to rally under the improved condition of the parts. Compression, by means of adhesive strips, applied concentrically from the margin to within a short distance of the centre of the carbuncle, is sometimes highly beneficial, the treatment greatly and rapidly assuaging pain and tension, and materially abridging the cure.

When the disease has passed into gangrene, as evinced by the cribriform and boggy condition of the affected tissues, the great remedy is free incision, the knife being carried, at different points, through the skin down to the healthy structures beneath. The operation at once relieves the horrible pain and tension of the parts, affords nature an opportunity of casting off the sloughs, and puts an effectual barrier to the further extension of the morbid action. Caustics in such a condition are far inferior to the knife, but if the latter is contraindicated, pure carbolic acid, which is the least painful of the escharotics, may be inserted into the openings or injected into the mass with a view of checking the spread of the inflammation and hastening the separation of the sloughs. If the dead tissues are slow in coming away, their extrusion may be expedited with the scissors, the surface of the ulcer being well touched immediately afterwards with dilute acid nitrate of mercury, or solid nitrate of silver, to promote the formation of healthy granulations. The accumulation of matter must be prevented and cleanliness insured by the frequent use of the syringe, charged with weak solutions of chlorinated sodium, carbolic acid, permanganate of potassium, or common salt. As soon as the sore assumes a healthy aspect the parts should be dressed with some mild unguent, as the opiate cerate, elemi ointment, or ointment of the balsam of Peru.

After recovery, the tendency to a recurrence of carbuncle, which is sometimes very strong, should be counteracted by a change of air, attention to diet, a proper regulation of the secretions, and the avoidance of exposure to cold, fatigue, and loss of sleep, conjoined with an alterative course of iodide of potassium, the dose of which should not exceed two grains and a half thrice in the twenty-four hours. If there has been much disorder of the secretions, a very minute quantity of bichloride of mercury may be advantageously conjoined with the potassium. When there is marked derangement of the digestive functions, attended with acidity and flatulence, chlorate of potassium may be given, three times a day, in doses of five to ten grains, until there is manifest improvement in the tone of the stomach and of the general health. A change of air is often indispensable to complete convalescence.

SECT. IV.—GANGRENE AND BEDSORES.

The skin is liable to gangrene, both idiopathic and traumatic, simple and specific, acute and chronic ; but as these several varieties have already received a sufficient share of attention, nothing need be said respecting them here. There is one species, however, which may be briefly described in this place, inasmuch as no special mention has been made of it elsewhere. I allude to what is called *white* gangrene of the skin, an affection the true character of which is still involved in obscurity, nothing that has yet transpired having thrown any light either upon its pathology or treatment.

White gangrene usually comes on without any appreciable cause or premonitory symptoms, in patches of irregular shape, from one to three inches in diameter. The sloughs are of a dead, milky color, and of hard, dryish consistence, yielding little, if any, moisture on pressure. Any portion of the body may be the seat of this affection ; but the arms, back, and chest are the regions most frequently implicated. The disease is ob-

served chiefly in old persons of a broken, anemic constitution. The treatment is conducted with special reference to the improvement of the health by tonics, brandy, and nutritious diet.

Bedsores.—There is another variety of gangrene of the integument which, from the frequency of its occurrence, and the severity of the attendant suffering, merits special attention here. Its immediate cause is steady and protracted pressure, impeding, and generally arresting, the circulation; hence it is exceedingly liable to arise on the sacro-lumbar region, the iliac projections, on the nates, and over the great trochanter, in consequence of long-continued confinement to one particular posture, as in typhoid fever, in severe fractures and wounds, and after surgical operations. It is also very common after violent injury of the spine. I have at this moment under my charge a tall young man, affected for the last six months with paraplegia, who has a large and excessively painful ulcer upon the left buttock, simply from the pressure sustained in sitting on a chair. Occasionally a sore of this kind forms with extraordinary rapidity, leading to the belief that it is due rather to the irritation of the spinal cord or the nerves thence arising than to any direct compression.

The disease is always necessarily preceded by inflammation, but in consequence of the absence of the usual symptoms, the want of proper care in examining these parts and keeping them clean, or the impossibility which the patient experiences in communicating a knowledge of his sufferings, as when he is exhausted by typhoid fever, or other causes, it does not always attract attention until great mischief has been done, eventuating in extensive sloughing, and the establishment of painful, irritable ulcers, which it is often extremely difficult to heal. In some instances the first intimation the patient has of the approaching mortification is a sense of prickling in the affected parts, as if he were lying upon some rough substance, as sawdust or coarse salt. At other times he feels severe pain, of a stinging or biting character, within a few days after he has been exposed to pressure, and which is often so constant and distressing as to deprive him both of appetite and sleep. Upon examining the parts to which the suffering is referred, the surgeon finds that they are red, or marked by an erythematous patch, slightly swollen, with a dense base, congested, and excessively tender on pressure. Ulceration, if it has not already taken place, will be sure to begin in a short time, unless suitable measures are adopted for the patient's relief, and will be speedily followed by mortification, or mortification may take place without being preceded by ulceration.

The extent to which the gangrene may proceed is variable; occasionally it occupies an immense surface, perhaps as large as the crown of a hat, and reaching down to the very bones; at other times it is more limited both in diameter and depth, laying bare merely the muscles, or being even, in great degree, confined to the skin. In rare cases the ravages involve the osseous tissue, and even the coverings of the spinal cord.

Bedsores, unless of very trivial extent, are among the most formidable complications that are liable to arise during the progress of fevers and other diseases, as well as after accidents and operations. As they seldom occur until the vital powers have been materially depressed, the excessive pain and drainage occasioned by them are often so severe as to destroy the patient, or, at all events, greatly retard his convalescence.

The *treatment* of bedsores, or gangrene from pressure, is prophylactic and curative. When there is any probability from the nature of the case that the confinement is likely to be tedious and attended with constant decubitis, or a helpless state of the patient, means should promptly be adopted for hardening those parts of the surface which long experience has taught us as being most liable to suffer under such circumstances. For this purpose they should be brushed once or twice a day with tincture of iodine, at first diluted, and then pure, or washed repeatedly with a saturated solution of alum and tannic acid. The greatest possible attention should be paid to cleanliness, and to the arrangement of the sheets and clothes, that they may not be rolled up under the body, and thus become a source of suffering and disease. As to the use of plasters, I have very little patience with them, for, unless they adhere well, they are extremely liable to become rumpled, much to the detriment of the part and system. Change of posture should receive early attention, although this is not always practicable, from the inability of the patient to maintain himself in any other situation than on the back. When it can be afforded, an air bed should be used, as this is preferable to everything else.

The moment any decided suffering is experienced, or the parts become red and inflamed, a ring-shaped air cushion should be provided for the purpose of equalizing the pressure, or, in the absence of this, an ordinary cushion, with a suitable central hole, the edges being broad and well padded with wool or horsehair. Such a contrivance, however, is a very imperfect substitute for an air or water cushion.

When gangrene is threatened, the best application is tincture of iodine, aided, if there be much pain and tension, by one or two moderately free incisions, and followed by a yeast or port-wine poultice, sprinkled with laudanum, morphia, or powdered opium. Cleanliness is promoted by the liberal use of the chlorides and by the early removal of the sloughs. When granulations begin to spring up, the best dressing will be opiate cerate, a mixture of equal parts of castor oil and balsam of copaiba, or mild mercurial, elemi, balsam of Peru, or blue ointment.

In the more rapid varieties of bedsores, dependent upon spinal irritation from external injury, with paralysis, Dr. Brown-Séquard strongly recommends the application of cold and heat, in the form of pounded ice and hop poultices, frequently alternated, with a view of effecting a salutary change in the circulation of the part. When the sore is indisposed to heal, on account of its inability to form healthy granulations, the most reliable stimulant is the galvanic current, applied in the manner pointed out in the chapter on ulcers.

The constitutional treatment of bedsores must be conducted according to the general rules followed in typhoid states of the system, from whatever cause proceeding. Nutritious food, wine, brandy, milk punch, quinine, iron, and anodynes, are the means chiefly to be relied upon for upholding the flagging powers of nature. This treatment can hardly be commenced too soon whenever there is any tendency to the formation of bedsores, for the very fact that such a disposition exists is a sufficient reason for redoubling our efforts to support the patient's system.

SECT. V.—BURNS AND SCALDS.

There are few accidents which are of more common occurrence than burns and scalds, or which entail a greater amount of suffering and deformity. The progress of civilization, and the improvements in the arts and sciences, have greatly multiplied their frequency and severity, and call for corresponding attention on the part of the surgeon. From what I have seen of these lesions, I am satisfied that few practitioners understand their character, or treat them with the success of which they are capable. One reason, perhaps, of this is that every one has a remedy for them, and that hardly any two agree as to the kind of treatment best adapted to their relief.

Burns and scalds differ from each other simply in this, that the one is the result of dry heat and the other of moist. They both present themselves in various degrees from the slightest erythematous blush of the skin to the total destruction of all the structures of a limb. Their extent is also extremely variable, both as it regards their depth and their superficial area. Thus, while in one case they may involve only a little patch of skin hardly the size of a half-dime, in another they may occupy an immense extent of surface; or, instead of being diffused over a large space, the injury may be concentrated upon a small spot, but penetrate to a considerable depth. These differences are of great practical importance, on account of the influence they exert upon the issue of the case. The division of Dupuytren of burns and scalds, so generally adopted at the present day, seems to me to be most complex and unscientific, and, therefore, well calculated to embarrass the progress of the inquirer. No one can doubt that the more simple the arrangement of a subject is, the more easily, in general, it is understood. In accordance with this idea, I shall describe burns and scalds as consisting of two classes, the simple and complicated, comprehending under the former term those lesions which, however extensive, give rise merely to inflammation, and under the latter those which cause the death of the parts, either on the instant, or within a short time after their infliction.

Burns are most common in winter, among the poorer classes, who are very liable to have their clothes set on fire from the manner in which they crowd around the hearth and grate to keep themselves warm. Women, on account of their peculiar occupations, are more subject to them than men, and children than grown persons. Blacksmiths, plumbers, glassblowers, and foundrymen are particularly exposed in this way. The introduction of gas, camphene, and petroleum has been a fruitful source of these casualties. Scalds, on the other hand, are most common in kitchens, breweries, factories, especially soap and candle, and, in short, in all places where steam is employed, whether for domestic or public purposes. On our western waters, where steamboat explosions are of such frequent occurrence, many persons are annually destroyed by the effects of hot water. Those parts of the body which are habitually exposed, as the hands and face, are most liable to suffer both from burns and scalds, particularly the latter, steam often penetrating the clothes in every direction. Dry and moist flame, hot water, and steam often enter the mouth and throat, producing violent, if not fatal effects. A heated iron has been known to be thrust up the rectum for the purpose of homicide, as in the famous case of Edward II.

Persons with a delicate skin not unfrequently suffer severely from long-continued exposure to the rays of the sun during the heat of summer, as is witnessed among soldiers, carpenters, bricklayers, masons, and farm hands. The affected surface exhibits a red, erythematous appearance, with or without vesication, and the pain is of a burning, itching, or smarting character. As the inflammation recedes, the epidermis drops off in small furfuraceous scales, leaving the surface beneath red and tender.

It is well known that different agents possess different degrees of capacity for caloric, and that, consequently, they are capable of producing different effects when brought in contact with the living tissues. Thus, experience has shown that boiling metal will cause a more severe impression than boiling oil, and boiling oil than boiling water. The intensity of the injury, however, is not always in proportion to the relative capacity of the substance for heat; for it is well ascertained that copper will, other things being equal, occasion a more violent effect than iron, although the latter possesses a greater capacity for caloric. This fact can be explained only on the assumption that some articles are not only better conductors of heat than others, but that they adhere more firmly to the surface, thus favoring its protracted extrication. Alcohol and ether, from their great volatility, usually produce superficial burns; oils, from their more adhesive properties, deep ones.

In the milder forms of these accidents there is merely an erythematous appearance of the skin, such as may readily be produced by exposing the back of the hand for a few moments to a stove, or by applying hot water to it. The discoloration is usually very transient, but at times it is more permanent, lasting for a number of hours, and being, perhaps, soon followed by slight vesication. The pain, of a smarting, pungent character, is comparatively trifling, and soon goes off. The constitution remains unaffected.

The application of heat, whether dry or moist, unless sufficient instantly to destroy the vitality of the part, or so slight as to make only the most superficial and transient impression, is always speedily followed by an evolution of vesicles, containing a thin, watery fluid, identical with the serum of the blood, from which it is derived. When the vesicles are more slow in forming, as when they are the product of the resulting inflammation rather than of the immediate effect of the caloric, their contents are, in general, partly fluid and partly solid, the latter consisting either of lymph or of fibro-albuminous matter. Their volume varies from a pin-head up to that of a fist, their number being usually in an inverse ratio to their dimensions. Cases are occasionally met with where the epidermis nearly of a whole limb, or of the greater portion of the trunk, is elevated into one enormous blister, establishing a most frightful drainage upon the system.

The surface around the vesicles is of a scarlet color, more or less tumefied, and exquisitely tender on pressure, and on exposure to the atmosphere. The pain is of a burning, scalding character, and so severe as to cause the most violent agony. The part rapidly swells, feeling stiff and tense, and the pain assumes a throbbing character. Well-marked constitutional symptoms are always present, especially if the lesion is at all extensive; and the patient may be delirious, excessively restless, and intensely thirsty.

These injuries are said to be complicated when they are attended with the destruction of the vitality of the part, or some other serious lesion, as a wound, fracture, or dislocation. The devitalization may be limited to the skin and subjacent connective tissue, or it may extend much deeper, involving muscle, aponeurosis, vessel, nerve, and bone all in one common eschar. Such accidents are never produced in any other way than by burns, as when a person falls into the fire, or gets his limb in a stove, grate, or furnace. Dreadful scalds, however, sometimes occur from the protracted application of boiling fluids, as happens, now and then, in breweries and soap factories. Under such circumstances, the loss of vitality, although not as extensive as we sometimes find it from the operation of dry caloric, is yet sufficient to be productive of the most terrible ravages. The epidermis comes off in large sheets, no vesicles exist, or only around the border of the injured surface, and the skin is of a dirty grayish, cineritious, or yellowish color, sodden, insensible, and marked, here and there, by a purplish line, indicating the course of a subcutaneous vein.

Besides the pain which invariable attends all burns and scalds, however slight, there is ordinarily more or less constitutional disturbance, coming on at a variable period after the accident; sometimes immediately, at other times not for several hours, days, or weeks. When the injury is at all extensive, all the symptoms of a severe shock will be present. The patient will feel exceedingly cold, or, perhaps, have violent rigors; the pulse will be small, frequent, and feeble; the respiration will be oppressed; and there will be extreme restlessness, along with great thirst and sickness at the stomach. He is, in fact, in great torture, pale, prostrated, agonized. When the shock is excessive, sensibility may be com-

pletely abolished. Reaction taking place, he will have violent fever, a flushed counte-
nance, and a quick, irritable pulse, with a tendency to delirium; pain, of a pungent,
burning character, forming all the while the prominent suffering. If the excitement run
high, there will be danger of overaction in the part, and of inflammation of some of the
internal viscera, the arachnoid membrane, and the mucous lining of the bowel. Numerous
cases have been published within the last twenty-five years going to show that ulceration
of the duodenum is one of the most frequent secondary lesions of scalds and burns; and, in
the more chronic forms of these accidents, the same disease is sometimes widely diffused
over the colon, thus accounting for the profuse and obstinate diarrhœa then so often present.

Albuminuria is a frequent, if indeed not a very common, occurrence in burns and scalds.
A large number of the cases admitted into the Pennsylvania Hospital show, according to
Dr. Morton, evidences of this occurrence. The urine is generally of high specific gravity,
and the quantity of albumen, although variable, is often so considerable as to be declara-
tive of at least more or less congestion of the kidneys. The change makes its appearance,
in violent burns and scalds, soon after reaction takes place, and usually increases in a
marked degree with the rise of temperature. No special clinical significance, certainly
no very serious one, attaches to the presence of albumen, as ordinarily found, in these
lesions. Similar changes, as is well known, not unfrequently occur in the urine after
various other injuries, and after many surgical operations.

Among the more common local consequences of burns and scalds are, the formation of
vicious scars, the adhesion of contiguous surfaces to each other, the retraction of the
affected parts, ankylosis of the joints, and various transformations of the cicatricial struc-
tures, especially the keloid. The scars, which are often of frightful extent, and horribly
disfiguring, possess an extraordinary contractile power, which does not cease for a long
time, which it is almost impossible to counteract, and which frequently draws out of place
every tissue that is brought under its influence, bone not excepted. Owing to this cir-
cumstance, the chin is occasionally drawn down against the sternum, as seen in fig. 241,

Fig. 241.　　　　　　　　　　　　　　　　　　Fig. 242.
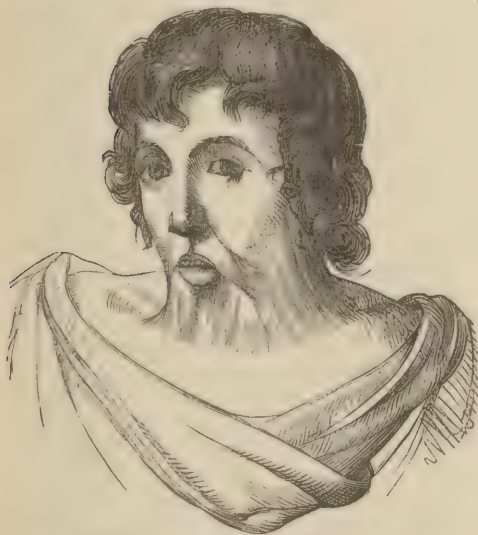
Vicious Cicatrices of the Face and Neck.　　　　Contraction of Elbow from Cicatrice of Burn.

and the lower maxilla singularly changed in shape. The fingers may be retracted like
claws, or literally buried in the palm, the hand thrown back at right angle with the wrist,
or the forearm drawn up against the arm, as in fig. 242, from a clinical case, which is
itself, perhaps, firmly pinioned to the side. Similar effects occur in the inferior extremity.
Thus, the foot is sometimes tied to the forepart of the leg, or the leg to the posterior sur-
face of the thigh. In neglected burns of the hand, the fingers are often united to each
other, so as to give them a webbed appearance.

Burns and scalds are among the most dangerous of accidents. If at all extensive they
often terminate fatally from mere shock of the system, without, perhaps, even the slightest
attempt at reaction; or, reaction occurring, life may be assailed by inflammation of some

internal organ; or death may take place at a more remote period, from the secondary effects of the lesion. A superficial injury of this kind is generally dangerous in proportion to its extent. Thus, a scald involving an entire limb, or the greater portion of the trunk, although merely affecting the external layer of the true skin, is always a most serious accident, liable to be followed by the worst results. On the other hand, the danger is hardly less when the lesion is very deep, even if it be not more than a few inches in diameter. When depth and great extent of surface coexsist, the chances are that death will occur without reaction, or soon after the system has rallied from constitutional irritation. Of 125 cases, collected by Erichsen and Holmes, 35 succumbed within the first forty-eight hours. After reaction has taken place, the great danger is from inflammation of the brain, lungs, and intestines, many of the worst cases perishing during the first fortnight. Inflammation of the duodenum, leading, as was originally pointed out by Mr. Curling, to ulceration of its mucous membrane, is an occasional occurrence, coming on, on an average, about the tenth day, the resulting sore, which is generally solitary, and situated just below the pylorus, being of a circular shape, sharp-edged, indolent, and unaccompanied by any characteristic phenomena. Burns and scalds of the chest and abdomen are the most common exciting causes. Death may be produced by hemorrhage, or by peritonitis from perforation of the bowel.

Such injuries are, other things being equal, more dangerous in infants and children than in adults, on account of the greater susceptibility of the nervous system. Old persons, too, are very intolerant of them, and are liable to suffer severely, both primarily and secondarily. Pregnant females occasionally abort from their effects; and in the intemperate they often give rise to delirium tremens and other distressing symptoms. A burn of the neck and scalp is liable to cause arachnitis; of the chest, inflammation of the lung and pleura; of the abdomen, peritonitis and enteritis. Finally, a patient, after having manfully struggled against ebb and tide, as it were, for weeks and months, may finally perish from the effects of profuse discharge, pyemia, erysipelas, or hectic irritation.

Treatment.—The indications in the treatment of these lesions are, first, to produce reaction and calm the system; secondly, to limit the resulting inflammation; thirdly, to promote the sloughing process, when death has taken place, and to favor the development of granulations; fourthly, to moderate contraction, and prevent ankylosis; and, lastly, to sustain the strength during the wasting effects consequent upon the protracted suffering which so often occurs when the patient has escaped from the primary effects of these injuries.

To raise the system from the depression or collapse into which it so frequently sinks, even in comparatively slight burns and scalds, immediate recourse should be had to a full anodyne, along with hot toddy, ammonia, sinapisms to the extremities, and the warm foot-bath, the immersion being cautiously continued from thirty minutes to an hour, according to the exigencies of the case. The quantity of morphia, or whatever form of opium may be used, should be at least double what it is in ordinary accidents, the system being always, under these circumstances, uncommonly tolerant of the medicine. A large dose will not only be conducive to speedy reaction, but will greatly assist in allaying pain and calming the system. If the shock has been unusually severe, it may be necessary, in addition to these means, to use stimulating injections and to rub the spine with some irritating lotion. In the child and the old man, care is taken not to urge on the reaction too rapidly, or to give opium without a certain degree of caution, lest the subsequent excitment should overtax the enfeebled brain and heart, thereby leading to visceral effusion. As the circulation comes up, the stronger stimulants are gradually withdrawn, the more simple alone being now trusted to for relief.

The severe pain consequent upon burns and scalds, is generally promptly relieved, as originally suggested by Dr. F. S. Waters, of Massachusetts, by the use of bicarbonate of sodium, applied in the former case, in the form of a paste made with water, and in the latter, in that of a powder freely sprinkled upon the raw surface.

The second indication is to moderate the resulting inflammation. With this view, various remedies may be employed; but what these remedies ought to be is a point respecting which there is still much contrariety of opinion. In the milder forms of burns and scalds the surgeon can hardly go amiss if he uses almost any of the more common popular articles. He will find that at one time the part and system are most comforted by cold applications, at another by warm; that the one is borne best to-day, the other to-morrow; that one patient is benefited by an ointment, another by a lotion; that in one case he may employ moist applications with most advantage, in another, dry; in short, that the utmost diversity obtains in regard to the tolerance of this remedy or that.

Cold applications are chiefly adapted to very young, robust subjects, during the heat of summer, but even then they should not be employed without the greatest care, on account of their liability to cause internal congestion and effusion. They should be used only so long as they are grateful and soothing to the system, and be discontinued the moment they are found to be disagreeable. They may consist simply of cold water, spirit and water, or weak solutions of acetate of lead; and the same articles may be applied warm, care being taken, when the one class follows the other, that the transition is gradual and gentle, not sudden and violent. If the lesion is very slight, the surface may be covered with poultices of scraped potato, apple, turnip, starch, arrowroot, or slippery elm; carded cotton; saturnine unguents; or cloths wet with liniment made of lime-water and linseed oil. The latter constitutes the famous application so much used at the Carron Iron Works in Scotland; it is, however, exceedingly filthy and disgusting, and should, therefore, be discarded from genteel practice. Carded cotton, an American remedy, has always stood high in the estimation of the public, and there are few articles which are more constantly or more advantageously employed in the treatment of superficial burns and scalds. Tincture of iodine diluted with two parts of alcohol, I have often found of great benefit in the milder varieties of these affections. It is only applicable, however, when the skin is unbroken. The burning, scalding, or smarting sensation, attendant upon this class of injuries, is often promptly relieved by pencilling the affected surface with a weak solution of nitrate of silver, and covering it immediately after with a thick layer of cotton.

In my own practice, I have found nothing so beneficial in the treatment of burns and scalds as carbonate of lead, in the form of white paint, a substance to which, in 1845, I called attention in a short article in Dr. Bell's Bulletin of Medical Science. Numerous observations made since that time by myself and others have only served to confirm the views which I then expressed. The remedy is more particularly applicable to the milder forms of these injuries, but I have also employed it with great advantage in the more severe. If vesicles exist, they must, as a preliminary measure, be evacuated with a fine needle, and the surface well dried, otherwise the lead will not adhere. The lead, mixed with linseed oil to the consistence of thick cream, is then freely applied with a soft brush, the dressing being completed by covering the painted surface with a layer of carded cotton, or old muslin, supported by a moderately firm roller. In the milder cases one such application, retained for several days, generally suffices; whereas in the more severe occasional renewal will be required, depending upon the amount and character of the discharge.

I have never witnessed any bad effects from white lead paint, applied as here directed, although I have used it very freely in numerous cases. In one instance, that of a negro girl, sixteen years of age, who had a most severe and extensive burn of the neck, chest, and abdomen, I continued the remedy for upwards of five weeks, consuming more than a quart of the lead, without observing the slightest injury. In short, my experience induces me to believe that the treatment is perfectly safe in all cases, whatever may be the extent or depth of the lesion, or the age of the patient. When a counterpoison, however, is deemed necessary, it will readily be found in the occasional exhibition of a dose of sulphate of magnesium, which, while it keeps the bowels in a soluble state, combines with the lead, forming an inert sulphate.

White lead paint probably produces its good effects in two ways: first, by forming a varnish to the affected surface, and, secondly, by directly obtunding its nervous sensibility. In many cases it literally acts like a charm, the patient in a few moments becoming perfectly calm, and passing, as it were, from torment to Elysium.

Professor T. G. Richardson, of New Orleans, has obtained excellent effects, in the treatment of burns and scalds, from the use of subnitrate of bismuth and glycerine converted into a thick paint, and freely spread upon the affected surface with a suitable brush, the parts being afterwards covered with carded cotton retained by a roller. In the milder forms of the accident a single application is often sufficient for a cure.

Dr. Addinell Hewson has employed with marked advantage in many cases of burns and scalds, of various grades, what he calls the earth treatment. It consists in covering the raw surface with finely sifted earth, either in the form of dry powder, or of a thick aqueous paste spread upon strips of old, coarse muslin, confined with a roller, and removed as soon as it becomes offensive or saturated with the discharges. In superficial burns and scalds one dressing often suffices for a cure, the parts healing underneath in a few days, the hardened mass coming off in a solid crust. In the more severe cases the application requires occasional renewal, sometimes as often as once every twenty-four hours. Of the efficacy of this plan of treatment I have had sufficient proof to satisfy me of the propriety of its employment. Its beneficial effects seem to be due to two circumstances, the exclusion of

the air from the raw surface, and the specific action of some of the ingredients of the earth, more especially the alumina. One great advantage of this mode of treatment is that the inodular tissue after the completion of the cicatrization is a great deal softer and much more pliant than after the use of any other remedies with which I am acquainted.

In Boston, a plan of treating burns and scalds is used with much advantage, consisting of the application of a thick coating of mucilage of gum arabic, which is immediately after well dusted with the dry powder, the whole forming a complete defence to the raw surface beneath. Mr. Meadows, of London, recommends, for a similar purpose, a mixture of collodion and castor oil, in the proportion of two parts of the former to one of the latter. The preparation, which may be kept ready for use for any length of time in an air-tight bottle, is applied by means of a camel-hair brush, and is speedily converted into a firm, adherent covering, the thickness of which may afterwards be increased if deemed proper. In the more simple forms of scalds and burns, the application of glycerine is occasionally very beneficial; and Dr. John H. Packard, of this city, has derived excellent effects from the use of fresh lard, both in the mild and the more severe varieties of these accidents. Dupuytren's favorite remedy was an aqueous solution of Goulard's extract, retained upon pledgets of old linen; and, with the exception of white lead paint, there is probably no more soothing application.

When a stimulant effect is required, as when the parts are in a condition verging upon gangrene, the most eligible dressing, perhaps, is Kentish's ointment, composed of one ounce of basilicon ointment and one drachm of spirit of turpentine, and spread upon strips of old muslin, bound on lightly with a roller; or, instead of this, the surface may be carefully pencilled with a weak solution of nitrate of silver, nitric acid, or acid nitrate of mercury, and then covered with a yeast, port wine, or tannic acid poultice. Thick soft soap also answers a good purpose, often promptly allaying the smarting consequent upon burns and scalds. When a mere protective is required, finely-powdered charcoal answers an excellent purpose, the surface being thickly sprinkled with it, and renewal effected as soon as the crust becomes saturated with the secretions.

Along with these means, proper attention is paid to the state of the constitution, the bowels are maintained in a soluble condition, diaphoretics are given to restore the functions of the skin, and the diet is carefully adapted to the particular emergencies of the case. The internal organs, especially the brain and lungs, are sedulously watched, any approach of danger from inflammation being promptly counteracted by suitable measures.

If, despite the utmost care and attention, the injury terminates in mortification, or if the parts were devitalized in the first instance, an effort should be made to check its further progress, and to promote the separation of the sloughs, the most eligible remedies being such as are in use for ordinary gangrene. Fetor is corrected with the chlorides. If the sloughs are very firm, they may be detached with the knife, the greatest caution being employed, lest pain and hemorrhage be induced.

As soon as the sloughs have dropped off, the indication is to promote the development of granulations; a circumstance which often requires much judgment and practical skill. One of the best remedies for this purpose is the warm water-dressing, with the addition of two drops of nitric acid to the ounce of fluid. Sometimes the calamine cerate is very soothing, and seems to do good when almost everything else fails. If the granulations manifest a tendency to exuberance, as they are very apt to do, they must be repressed with the scissors, nitrate of silver, and systematic compression, tonics being given to support the system. Cases occur in which these bodies are rendered exquisitely sensitive, the slightest touch being followed by the most lively pain. This condition is generally attended with an irritable state of the constitution, for the relief of which something more than mere topical medication is required. A judicious course of anodynes and tonics, with the occasional application of nitrate of silver, and the constant use of an elm-bark poultice, constitute the proper treatment. Occasionally, no local remedy is so soothing as white lead paint. Whatever means may be employed, it will be found that they will require to be frequently varied, as one loses its effects another taking its place.

In burns from the effects of solar heat, prompt relief is generally afforded by applications of cold water, either simple or medicated with acetate of lead. In the more severe cases the affected surface should be thickly covered with white lead paint.

To obviate deformity constitutes the fourth indication in the treatment of these injuries. The points to be attended to are threefold: first, to prevent adhesion between contiguous surfaces; secondly, to counteract the tendency to vicious contraction; and, thirdly, to guard against ankylosis.

The tendency which the contiguous surfaces have to unite with each other during the

progress of these accidents has already been alluded to. This tendency is not confined to the fingers and toes, but is also exhibited in other parts of the body, as between the arm and trunk, the labia, the thigh and scrotum, the ear and scalp. Wherever it appears, it must be carefully counteracted by the use of the bandage and the interposition of lint, aided, if need be, by splints. It does no credit to a surgeon to send forth his patient, after the completion of cicatrization, with webbed hands and feet, or with his arms pinioned to the side of the chest, although such occurrences are not always entirely avoidable.

The disposition to contraction in burns and scalds attended with loss of substance is always great, and is often productive of the most frightful deformity. To counteract this disposition, recourse should be had, early in the treatment, to carved splints and wire cases, judiciously applied, and steadily used, not only until the parts are well, but for a long time afterwards; experience having shown that the tendency to contraction continues for months, if not for years, after the completion of the cicatrization.

If, from neglect, mismanagement, or unavoidable circumstances, the contraction has seriously impaired the usefulness of the part, or greatly marred good looks, relief should be attempted by the division of the offending cicatrice, or, perhaps, by its excision, the raw edges being afterwards united by suture, or adapted to a flap of the adjacent integument. This operation, constituting what is termed *dermoplasty*, and in connection with which the names of Mütter, Pancoast, and Teale deserve especial commendation, should not, however, be undertaken without due preparation of the system; for it is easy to perceive that, when the cicatrice is very large, two most extensive wounds would have to be made, thus inflicting a violent shock upon the constitution, extremely liable to be followed by erysipelas and a low form of fever, under which the patient might readily sink.

The operation should be performed while the patient is under the influence of an anæsthetic, with the precaution of dissecting out every particle of the inodular tissue. To accomplish this, the surgeon is sometimes obliged to pass deeply among important vessels and nerves, which must, of course, not be interfered with. In conducting such an operation about the neck, care must be taken to prevent the entrance of air into the veins. The bleeding which attends the excision of the cicatrice is generally trifling, and is easily arrested by torsion: when the ligature is unavoidable, it should be composed of raw silk or carbolized catgut, and be left in the wound.

The skin for filling up the gap left by the removal of the inodular tissue should always be taken from the immediate vicinity of the part. Thus, in the neck, it is usually obtained from the shoulder or top of the chest, and, when the wound is very large, two flaps are generally made, one on each side, the object being to guard against sloughing from inadequate nutrition. Due allowance must always be made for shrinkage. Hence the flap should invariably be at least from one-fourth to one-third larger than the wound, have a good, broad pedicle, and be well stitched in its new position, although care must be taken not to place the sutures too near each other, for fear of embarrassing the circulation. The central portions of the flap must be loosely confined with adhesive strips, and the edges covered with charpie, soaked in oil. The wound made by the transplantation of the integument is immediately closed in the usual manner. The parts are kept perfectly at rest, being immovably fixed by suitable apparatus, and the case is afterwards managed according to the general principles of plastic surgery.

Although the results of this operation have been much lauded, my confidence in its ultimate efficacy has been a good deal shaken, experience having shown that, in very many cases, more or less of the deformity for which it was performed will be sure, at no distant day, to recur, the more especially if any portion, however small, of the inodular tissue is left. For this reason few of such procedures can be classed among the triumphs of surgery. It is only when the cicatrice is very soft and superficial that they hold out any prospect of a permanent cure. When the contraction involves the muscles, tendons, fibrous membranes, and bones, forcing them out of their natural shape and position, the art of surgery can be of no avail.

The late Mr. Skey, of London, with a view of obtaining extension of the vicious cicatrice, was in the habit of making numerous minute incisions, extending both through the skin and the subjacent tissues, basing his practice upon the assumption that the contraction of a wound is slight in proportion as the time consumed in the healing process is short. It does not appear, however, that this practice has had any imitators, and I should certainly have no faith in its efficacy or permanent utility.

Skin-grafting will no doubt be found to be of essential service in promoting the cicatrization of burns and scalds, and should be practised as soon as the granulations have assumed a sufficiently healthy appearance to justify the belief that the transplanted skin

will be able to take root and grow. Whether this expedient, however, will prevent the extraordinary tendency to contraction so often witnessed after these lesions, is very questionable. Of several cases which have come to my knowledge, among others one mentioned to me by Dr. J. M. Barton, no permanent benefit resulted.

The joints often become involved during the progress of burns and scalds, either from direct inflammation, or in consequence of the contraction of neighboring muscles, tendons, and aponeuroses. The parts are carefully watched, being moved from time to time, and constantly retained in splints, until all tendency to ankylosis has ceased.

Finally, the secondary constitutional irritation and drainage, so common, and so hazardous in the more severe forms of these accidents, must be met by stimulants, tonics, and anodynes, along with nutritious food, and exercise in the open air. Any diarrhœa that may be present must be checked with opium and astringents, of which acetate of lead and sulphate of zinc deserve particular mention, the former being given in doses of two grains, and the latter in half that quantity, with half a grain of opium, three times in the twenty-four hours. Night-sweats are controlled with atropia, quinine, and elixir of vitriol.

Secondary amputation may be necessary, when, an attempt having been made to save the part, death is likely to occur from the excessive discharge and hectic irritation ; or when the part is found not only to be useless, but to be greatly in the way of the patient's comfort and convenience.

SECT. VI.—FROST-BITE AND CHILBLAIN.

Man possesses in a remarkable degree the faculty of resisting the influence of physical agents. His constitution is able to bear almost any amount of heat and cold, provided the transition from the one to the other is not too great or sudden, and that he himself is at the time in the full enjoyment of his bodily powers. The experiments of Fordyce, Blagden, and others, show what an amount of artificial heat may be endured without entailing any serious effects, and the experience of travellers, as Banks, Solander, Kane, and Hayes, is equally decisive in regard to his capacity of withstanding the effects of low degrees of temperature. It is only, or chiefly, when the alternation from heat to cold is very rapid, or when the application of cold is made in a very concentrated form, upon a part of the body the circulation of which is naturally very languid, that severe consequences are apt to ensue. Baron Larrey, who enjoyed extraordinary opportunities of studying the effects of cold, during Bonaparte's celebrated retreat from Russia, was forcibly struck with the little suffering the soldiers experienced when exposed even for several successive days to the influence of a very low, dry, uniform temperature. Thus, after the battle of Eylau, although the mercury had fallen fifteen degrees below zero of Réaumur's thermometer, none of the French troops complained of frost-bite, notwithstanding many of them had remained in the snow, in an almost inactive state, for upwards of twenty-four hours. Presently, however, a fall of sleet coming on, during which the temperature rose suddenly from eighteen to twenty degrees, immense numbers of those who had been exposed began to suffer from the effects of cold, consisting principally in sharp, pricking pains in the remote parts of the body, especially in the feet, and in a disagreeable sense of numbness and weight. Severe swelling soon followed ; the skin assumed a dusky, reddish appearance ; the joints became stiff and insensible ; feeling and warmth rapidly diminished ; and black spots formed at the roots of the toes and on the back of the foot, announcing the occurrence of gangrene, the extremity looking dry and shrivelled, as in chronic mortification. It was observed that those who had warmed themselves at fires suffered more severely than those who had been more discreet in this respect.

Frost-bite was very prevalent among the English troops during their first winter in the Crimea, and the French suffered in still larger numbers, as well as more severely. The habit which the men had of sleeping in their wet boots, at one time almost universal, contributed greatly to its production, wet and cold combined diminishing the circulation and the vitality of the feet and toes. On the 21st of January, 1855, when, according to Dr. Macleod, the thermometer stood at 5°, not less than 2500 cases of frost-bite were admitted into the French ambulances, and of these 800 died, death in many having no doubt been expedited by the effects of erysipelas, pyemia, and hospital gangrene.

The first effect of dry, cold air is a sense of numbness and weight, with a peculiar prickling or tingling, and an afflux of blood to the surface, giving it a lively reddish appearance. If the impression be maintained for any length of time, the parts become stiff and perfectly insensible ; and the blood, retreating from the surface, leaves it of a pale, whitish aspect, contrasting strikingly with the previous discoloration. When the cold is intense, and suddenly applied, so as speedily to overwhelm the parts, the skin

occasionally is raised into blebs or vesicles and exhibits a mottled appearance, depending upon the presence of coagulated blood in the subcutaneous veins.

The effects of moist cold are very similar to those of dry cold. Upon immersing the hand, for instance, in iced water, there is generally an immediate rush of blood to the surface, and a decided augmentation of its color, soon succeeded by an unpleasant tingling sensation and a marked degree of numbness. By and by, however, the surface becomes white, the skin is elevated into blebs or blisters, exquisite pain arises, and the whole limb notably shrinks. There is thus, in fact, no essential difference in regard to the effects of these two varieties of cold; and the observer cannot fail to perceive how closely the first impressions of both resemble those produced by the application of artificial heat, especially in its dry form.

All parts of the body are liable to suffer from the effects of cold: excepting, however, those rare cases, where the impression has been maintained for an unusual length of time, the toes, feet, heels, fingers, hands, nose, and ears, together with the lips and cheeks, will be found to be more frequently affected than any other structures. Accidents of this description are most common among the poorer classes, those wretched beings whose system is broken down by starvation, intemperance, and every kind of exposure and hardship, tending to depress the vital powers, and to predispose to the development of disease. Sailors and the boatmen on our lakes and rivers are particularly liable to frost-bite.

The primary effects of cold upon the general system are those of an agreeable stimulant: the circulation is increased in force and frequency, a slight glow pervades the surface, and the individual is universally exhilarated. By and by, this agreeable feeling is changed into one of pain and torpor; the brain is oppressed as if under the influence of a powerful narcotic; the whole body is cold and benumbed; and the person, overwhelmed by drowsiness, is obliged to make the most powerful efforts to keep awake. If, in an unlucky moment, he should yield to his inclinations, away from friends and assistants, he sleeps to wake no more; the blood rapidly settles in the internal organs; the nervous fluid ceases to be generated; the respiration becomes heavy and stertorous, and death takes place very much as in ordinary apoplexy. Should the individual, after long and severe exposure, be suddenly brought into a hot room, or placed near a fire, he will run the risk of speedily perishing from asphyxia, brought on by the repulsion of the blood to the brain and lungs; or, should he survive a short time, the frost-bitten parts will be seized with gangrene, the spread of which, as observed by Larrey, is often so rapid and striking as to be perceptible by the eye.

Such are some of the more important local and constitutional effects of cold, when applied in its more severe and protracted forms. As just seen, it may prove destructive both to the part and system; or, reaction taking place, the patient may recover, although he will be likely afterwards to suffer more or less in various parts of the body, especially the feet, ears, nose, and fingers, from the secondary effects of his accidents, which are often as distressing to him as they are perplexing to the practitioner.

Treatment.—The treatment of frost-bite requires no little judgment and adroitness to conduct it to a successful issue. The great indication is to recall the affected parts gradually to their natural condition by restoring circulation and sensibility, in the most gentle and cautious manner, not suddenly, or by severe measures. The first thing to be done is to immerse them in iced water, or to rub them with snow, the friction being made as carefully and lightly as possible, lest overaction be produced, as they are necessarily greatly weakened. If no ice or snow is at hand, the coldest well-water that can be procured must be used; and if the immersion is inconvenient, wet clothes are applied, with the precaution of maintaining the supply of cold and moisture by constant irrigation. Moderate reaction is aimed at and fostered. All warm applications, whether dry or moist, are scrupulously refrained from; the patient must not appproach the fire, immerse his limbs in hot water, or even be in a warm room, otherwise mortification or other disastrous consequences will be certain to follow.

As soon as the natural temperature has been in some degree restored, slightly stimulating lotions will be found serviceable, such as weak solutions of camphor, soap liniment, or tincture of arnica with the addition of a few drops of ammonia to each ounce of fluid. The parts are placed at rest, in an easy and rather elevated position, and lightly covered with a blanket; or, what is better, exposed to the warm air of the apartment, there being now no longer any necessity for keeping the patient in a cool room, as there was in the earlier stages of the treatment. Some mild cordial may now also be given in small quantity, along with a little warm gruel or broth. If the local reaction threaten to be severe, it must be checked by astringent and cooling lotions, attention to position, a

properly regulated diet, and the exhibition of a purgative. For incipient mortification, consequent upon cold, the best remedy is dilute tincture of iodine.

Dr. Hayes, the companion of Dr. Kane in his last Arctic voyage, gives an account of a mode of treatment of frost-bite pursued by the Esquimaux, which deserves brief mention, although it does not differ essentially from that just laid down. A native, says the writer, who had his leg frozen above the knee, to such an extent that it was stiff, colorless, and apparently lifeless, was placed in a snow-house at a temperature of 20° degrees below zero. The parts were now bathed with ice-cold water for about two hours, and then enveloped in furs for about twice that period. At the end of this time frictions were commenced, first with the feathery side of a bird's skin, and then with snow, alternately wrapping the limb in furs, and continuing the rubbing for nearly twenty-four hours. The limb was now carefully covered, and the temperature of the room elevated by lamps above zero. On the third day the man was removed to his own house, and in seventy hours he was able to walk about, with only a slight frost-bite on one of his toes.

When a person has been overpowered by cold, or is nearly frozen to death, the attempts at restoration must be conducted upon the same general principles as when he is suffering merely from the local effects of cold; that is, he should be put in a cool room, and be gently but efficiently rubbed with flannel, wet with brandy, spirit of camphor, or ammoniated liniments, gradually followed by dry frictions and warm covering. If he can swallow, brandy should be given by the mouth, or this or some similar article should be thrown into the rectum; stimulants should be cautiously applied to the nose, especially snuff, and sinapisms to the precordial region, the stomach, and spine. As the circulation and respiration improve, the temperature of the apartment may be gently elevated, and warm broths, or wine whey, or, what is better, warm toddy, administered. The efforts at resuscitation should not be discontinued too soon, since they have occasionally been crowned with success long after all reasonable expectation of recovery had ceased. The practice formerly recommended of immersing the whole body in cold water, in this condition, cannot be too much deprecated, as it could not fail to prove exceedingly injurious.

Pernio or chilblain.—The secondary effects of cold are usually described under the name of pernio or chilblain, and there are several varieties of form in which they may present themselves, as the erythematous, ulcerated, and gangrenous. These effects may supervene upon slight exposure, and hence they are occasionally met with among the better classes of citizens, the parts most liable to suffer being the toes, heel, instep, ears, nose, and fingers. They are usually preceded by a slight vesication, and by burning, tingling sensations, as if the surface had been held near the fire. These effects may soon subside, or they may prove a source of annoyance for many months; in general, however, they are of a transient nature, but the parts, instead of getting completely well, remain weak and congested, and are liable to new attacks of suffering from the slightest causes. Any sudden change in the weather is extremely apt to bring on a paroxysm; the affected structures become red, or of a dusky, purplish hue, swollen, painful, and œdematous; the epidermis is often raised into little blisters, distended with yellowish, turbid, or sanguinolent fluid; and there are few cases in which itching, sometimes almost insupportable, is not a prominent symptom, the patient feeling as if he could tear the parts to pieces.

Ulcers not unfrequently form as an effect of frost-bite. Generally preceded by slight vesication, they are superficial, irritable, and indisposed to heal, the discharge being of a thin, ichorous character; the parts around are red, inflamed, and congested, and the erosive action often spreads over a considerable surface. In some cases it extends very much in depth, and may thus ultimately invade a neighboring joint, bone, tendon, or muscle.

Gangrene is more frequently a primary than a secondary effect of frost-bite; the affected part is of a dark brownish, purplish, or blackish color, cold, insensible, and exquisitely fetid; in some cases the slough is dry and shrivelled, like a rotten pear, in others it is moist and expanded. In persons of weak constitution, and in the more remote parts of the body, where the circulation is naturally very feeble and languid, it often spreads to a considerable extent; but, in general, its tendency is to limit itself to a small space. When considerable, it may invade all the component tissues of a limb, the bones and joints as well as the soft parts.

Pernio may, as already stated, last for many years, alternately disappearing and recurring under the slightest local and constitutional changes. Atmospheric vicissitudes generally exercise a marked influence upon these attacks, the patient being often a complete barometer; a combination of cold and moisture is particularly prejudicial. During the dry weather of summer the disease not unfrequently disappears spontaneously, but is sure to return on the approach of winter. In this manner life may be rendered perfectly

miserable, especially when the chilblain is seated in the feet, the patient being hardly ever able to walk with any degree of comfort or satisfaction.

In the *treatment* of pernio, remedies of a slightly stimulating character are most entitled to confidence. The milder forms of the disease are often speedily relieved by immersion of the part in cold water, followed by the use of a strong solution of acetate of lead and opium, or, what is preferable, dilute tincture of iodine, which, on the whole, I have found to be more beneficial than any other article. Sometimes prompt amelioration is afforded by the application of carded cotton, soap liniment, spirit of camphor, or some other stimulating embrocation.

Any blisters that may form should immediately be opened, and the affected surface freely touched with solid nitrate of silver, or painted with very dilute tincture of iodine. Not unfrequently excellent effects follow the use of weak citrine ointment, or of benzoated zinc ointment. In obstinate cases great advantage often arises from thorough vesication with cantharidal collodion.

The gangrenous form of pernio is treated upon general principles. Fetor is allayed by deodorizers, and sloughs are removed as they become detached. Amputation is refrained from until there is a well-marked line of demarcation, and even then the surgeon should hesitate if the system is not in a healthy condition. Baudens asserts that most operations of this kind, performed in the Crimea, on account of frost-bite, were unsuccessful, owing to the shattered and wasted state of the sick, the great majority of whom had been affected with diarrhœa.

In all cases proper attention must be paid to the general health, the diet being duly regulated, the bowels gently evacuated, and the secretions improved. From neglect of these precautions great temporary suffering is often induced.

SECT. VII.—HYPERTROPHIES OF THE SKIN.

Under hypertrophies of the skin are included two diseases, of which one, dermatolysis, consists of enormous development of the integument as a whole, and the other, elephantiasis, is composed of excessive enlargement of the individual elements of the skin and subcutaneous connective tissue.

1. DERMATOLYSIS.—Dermatolysis, or pachydermatocele, occurs chiefly, if not exclusively, as a congenital affection. It is characterized by a soft, pendulous condition of the skin, which hangs off in loose folds from the surface to which it is naturally attached, as if it had been stuck on without any special object. In all other respects, the integument is apparently perfectly normal, there being not the slightest alteration of color, consistence, or structure, at least so far as we are enabled to judge from inspection. The most common sites of hypertrophy of the skin are the nates, scrotum, prepuce, and vulva. The most remarkable example that I have met with occurred, as a congenital vice, on the back of the neck of a female child, upwards of a year old, the integument forming a large pendulous mass, of a doughy, inelastic feel, extending from ear to ear, and causing unseemly deformity. The child was, in other respects, well formed.

When the hypertrophied integument forms an unsightly mass, or when it proves inconvenient by its bulk, it should be included in an elliptical incision, care being taken not to cut away so much of the skin as to interfere with reunion. If the tumor is very large, and the patient of tender age, the employment of the knife should be postponed until the constitutional stamina are sufficiently developed to enable the child to bear the shock attendant upon so severe an operation. Special pains should be taken to guard against hemorrhage, which might otherwise be profuse.

2. ELEPHANTIASIS.—Arabian elephantiasis, Egyptian sarcocele, tropical bucnemia, spargosis, or the glandular disease of Barbadoes, as it is variously denominated, although uncommon in this country, deserves passing notice, not less on account of the hideous deformity which it induces than its obstinate and intractable character. The favorite seat of this singular disease is the leg, which often acquires an enormous volume and a most grotesque appearance, causing a striking resemblance to the leg of the elephant, whence its name. It is not, however, confined to this part of the body; on the contrary, it is liable to occur in various organs, particularly the scrotum, prepuce, and pudendum, which, in consequence, sometimes acquire an enormous bulk. A tumor of this kind, presented to me by Dr. Bozeman, and removed by him from the genital organs of a negro, weighed forty pounds; and Clot-Bey extirpated one, occupying a similar situation, which weighed one hundred and ten pounds. The adjoining cut, fig. 243, taken from a clinical case, affords a good illustration of elephantiasis of the foot and leg. The enormous bulk

Fig. 243.
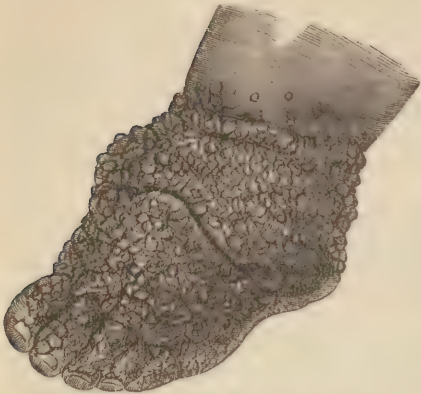
Elephantiasis of the Foot and Leg.

which the lower extremity may attain in this disease is well shown in a case reported by Dr. Isaac Smith, of Massachusetts, in which the weight of the limb after amputation exceeded one hundred pounds. Dr. Carnochan has recorded a remarkable example of elephantiasis of the head, face, ears, and neck in a woman of forty-four years of age.

The disease is met with in both sexes, but much oftener in males than in females; it occurs in various races of men, and frequently begins at an early age, although it is most common in young adults. In this country and in Europe the affection is very rare, but in certain parts of Asia, Africa, Syria, Arabia, Egypt, and the West Indies it is extremely prevalent, and sometimes even endemic. It occasionally occurs in several members of the same family; and cases have been recorded in which it was hereditary. In the swampy districts of Bengal, where elephantiasis is exceedingly common, especially in the genital organs, its origin is sometimes apparently due to malarial influences.

Of the intimate nature of elephantiasis nothing satisfactory is known. The disease is evidently of an inflammatory character, but how this is brought about we are entirely ignorant. It has been supposed to be owing to an obstruction of the principal veins of the affected parts, impeding the return of blood, and thus creating congestion and irritation, followed by plastic exudation in the interstices of the cutaneous and connective tissues. From the fact that attacks of erysipelas are not uncommon in the earlier stages of the disease, or, rather, that this affection not unfrequently precedes the outbreak of elephantiasis, it has been imagined that it is essentially dependent upon the disturbance which it occasions in the nutritive and secretory functions of the parts. Others, again, have been led to conclude that the malady essentially consists in an inflammation of the lymphatic vessels, attended with plastic deposits within and around these vessels, and in the lymphatic glands, whereby their caliber is choked up, and, as a necessary consequence, their contents are prevented from discharging themselves into the thoracic duct. This view is, on the whole, extremely plausible, for it really comprises all the cardinal elements of a consistent theory, which the others do not. That there is, in this disease, serious mechanical obstruction of some kind or other, is unquestionable, and I know of none that would be more likely to produce such a result than compression of the lymphatic vessels. If then, it is allowable, in the existing state of the science, to frame a doctrine in respect to the origin of an affection so obscure as elephantiasis is acknowledged to be, we may conclude that it is an inflammation of the absorbents, attended with obstruction of their caliber, and deposits of lymphoid cells, which, becoming gradually organized, are ultimately converted into an analogous fibrous tissue, thereby completely changing the character of the primitive structures, especially the cutaneous and connective.

Dissection shows that the epidermis in this disease is very much thickened, rugose, and so firmly adherent as to come off with difficulty. The cutis is of a whitish color, striated in its texture, and very hard and dense, cutting almost like the rind of bacon. In many cases it is from a quarter of an inch to half an inch in thickness. The papillæ are enormously hypertrophied, and of an elongated shape, forming large bodies which stand off prominently from the substance of the true skin. The connective tissue is completely changed in its character; its areolæ are obliterated, and their place is supplied by a dense, inelastic, fibroid substance, exhibiting none of the properties of the original, interspersed with and occupied by irregular lacunæ filled with lymph or stuffed with desquamated endothelium. In elephantiasis of the leg, the muscles, compressed by the new matter, and deprived of activity, are found to be wasted, pale, and in a state of fatty degeneration. The bloodvessels are generally very much enlarged and thickened, and hence, when an attempt is made to extirpate the morbid mass, as when it occupies the genital organs, tremendous hemorrhage is to be expected. In some cases, however, the larger veins are obliterated, especially in elephantiasis of the lower extremity. The principal nerves have a white, flattened appearance, and are sometimes apparently augmented in size, forming true neuromas. Under the microscope the newly formed tissue—

that upon which the increased volume of the affected parts essentially depends—is found to be uniformly composed of free nuclei, cells, and fibres, in every stage of development, precisely similar to those of a fibroid tumor, properly so called. The development of lymphoid cells, forming thick sheaths around the vessels, is in some instances very striking.

The symptoms are variable. Often, if, indeed, not generally, the disease comes on suddenly and unexpected, without any apparent local or constitutional cause. At times, however, its development is directly traceable to local injury, as a blow, sprain, or contusion; and in quite a number of cases it has seemingly followed upon the protracted immersion of the parts in cold water, the occupation of the individual compelling him to pursue such a habit. The symptoms are at first of an inflammatory type; the affected surface, red and painful, pits on pressure, and imparts a nodulated, cord-like sensation to the finger; the subcutaneous connective tissue is hard and infiltrated; and the movements of the diseased structures soon become stiff, awkward, and embarrassed. Sometimes red lines or streaks extend along the course of the lymphatic vessels, as high up as the nearest glands, which are themselves more or less tender and swollen. Considerable febrile commotion is generally present, but this soon subsides, and the disease gradually lapses into a chronic state, which often ceases only with the patient's life. In the more confirmed cases, fatty degeneration of the other organs occasionally exists.

The diagnosis of elephantiasis is unmistakable, as there is no other affection which bears any resemblance to it. Once seen, it can never be forgotten. The part is not only enlarged; but enormously increased in weight and consistence; it feels heavy and cumbersome, and is as hard, dense, unyielding, and rough as the leg of the animal from the resemblance to which it has derived its name. The surface of the skin, usually much darker than natural, is fissured, grooved, nodulated, or tuberculated, and completely deprived of its normal sensibility. Sores occasionally form upon it, and, gradually spreading in diameter and depth, add greatly to the local distress. Sometimes small, hard, shining scabs exist, not unlike those of ichthyosis. The chronic march of the disease, the remarkable deformity of the affected parts, and the peculiar condition of the skin, will always prevent it from being confounded with anasarca, the only lesion which bears any resemblance to it.

The disease, once fully established, may remain stationary for years, or even during the remainder of life, or it may go on gradually increasing until the affected parts have acquired a volume and a weight many times beyond the natural state. Even under these circumstances, however, the suffering is chiefly of a mechanical character, the general health often continuing good to the last. It is only, in fact, when intractable ulcers form, with an abundant discharge of pus, that the constitution is likely to give way under the local drain and irritation. The prognosis is of course most unfavorable in those countries where the disease is endemic; in Europe and the United States, where it occurs only as a sporadic affection, very few die of it.

There is a form of elephantiasis to which the term nævoid is strictly applicable, as it consists essentially in an enlargement of the affected parts, caused by the presence of a great quantity of dense connective tissue, inlaid with venous structures of a cavernous character, with numerous meshes, not unlike the cavernous structure of the penis, of variable size and shape, some being very fine and delicate, and others equal to the volume of a small marble. The disease is always congenital, and, like ordinary elephantiasis, is generally attended with excessive deformity, its most common site being the lower extremity. The skin is thickened, rugose, very dense, and more or less tuberculated. The tumor can be diminished by pressure, but immediately returns to its former bulk when the pressure is removed. The principal veins and arteries of the part are generally somewhat enlarged.

The *treatment* of elephantiasis is, at best, very unsatisfactory, however early it may be commenced, or however perseveringly and judiciously it may be conducted. Regarding the disease as essentially consisting in inflammation of the lymphatic vessels, or of these vessels and the veins, the most rational plan of treatment that suggests itself is the antiphlogistic, of which leeching, blistering, and the application of tincture of iodine are among the more important and reliable means. The object, in the first instance, should be to reduce local action, in order to prevent subversion of structure. Hence the sooner these remedies are applied, the more likely they will be to effect resolution. As a sorbefacient, no article holds out such strong hopes of relief as tincture of iodine, used either pure or variously diluted to suit the exigencies of each particular case. It not only promotes the removal of effused fluids, but produces a powerful revulsive and antiphlogistic action, and should be employed, steadily and persistently, for many months together. The effects of the treatment will be greatly augmented if the parts be occasionally scarified, to

relieve engorgement, kept at rest in an elevated position, and well bandaged, strapped, or mechanically compressed. Inunction with very dilute ointment of biniodide of mercury also sometimes proves highly beneficial; and, in the earlier stages of the complaint, lotions of acetate of lead, chloride of ammonium, and of rectified spirit, are worthy of trial, especially when there is much pain, with a tendency to rapid effusion and organization. Whatever the local remedies may be, they should invariably be aided by the use of the bandage, renewed twice in the twenty-four hours. I have witnessed good, although not permanent, effects from the earth dressing of Dr. Addinell Hewson.

Constitutional treatment is not to be disregarded. The action of local remedies will be greatly promoted by a restricted diet, by the occasional use of a brisk cathartic, and by the steady influence of saline and antimonial medicines, with a few grains of calomel every night at bedtime, until slight ptyalism is induced. Even general bleeding might be advantageously employed at the beginning of the treatment, in persons of a robust and plethoric state of the system.

When the malady has attained an extraordinary degree of development, or has gone on for many years progressively increasing, or has remained stationary for a long time, no treatment at present known, not even ligation of the principal arteries of the affected tissues, will be likely effectually to eradicate the disease, or, more properly speaking, enable the parts to resume their primitive condition. All topical and general means are, under such circumstances, absolutely unavailing; and the utmost that can reasonably be expected from cutting off the supply of blood to the part is a diminution of its size, not complete restoration of its normal condition. Professor Carnochan deserves great credit for the laudable effort he made, in several cases of elephantiasis of the leg, to arrest the morbid growth, and ultimately cause its absorption, by ligation of the femoral artery; but, although his patients, three in number, were, from all accounts, much benefited, it is questionable whether, in any, a complete cure has been effected. In 1857, I was present at the Philadelphia Hospital, when Dr. Campbell, then surgeon-in-chief, performed an operation of this kind upon a negro, about fifty years of age, who had long been afflicted with this complaint in one of his legs; but the result was not at all encouraging. I saw the man occasionally afterwards for many months, and during my last visit to him, more than a year after the operation, the limb had not undergone any material change, either in volume or consistence. Indeed, such a procedure could hardly be expected to eventuate favorably, when we take into consideration the excessive transformation of the parts and the astonishing enlargement of the branches of the femoral artery. The operation might, if performed early in the disease, and, if conjoined with the use of sorbefacients and the rubber bandage, be worthy of further trial, but its indiscriminate employment is certainly not to be commended. Several cases have been reported by Defour, Vanzetti, and others, in which a cure of this disease is said to have been effected by diminishing the supply of blood in the affected structures by compression of the femoral artery.

Since Dr. Carnochan performed his first operation for the cure of this affection, in 1851, a number of other cases have occurred. Dr. George Fischer, of Hanover, in 1869, published a table of 21 cases, including one of elephantiasis of the neck, face, and ears, of which only 4 were positively known to have terminated successfully. Among the failures were 3 relapses, 2 deaths, and 1 amputation, on account of gangrene of the limb. Dr. Bauer had an instance in which the ligation of the femoral artery was followed by marked relief at the time it was reported, several months after the operation. How far these cases were benefited by the associated treatment, as compression and sorbefacient lotions and unguents, is a point which does not seem to have been well considered. In Dr. Carnochan's patient, a woman forty-four years of age, affected with elephantiasis of the head, face, ears, and neck, only a partial cure was effected by the ligation of both primitive carotid arteries after an interval of six months. In three cases of elephantiasis of the leg treated by ligation of the femoral artery, by Sir J. Fayrer, then of Calcutta, one died of pyemia, and in the other two no permanent benefit accrued from the operation. Dr. McGraw, of Detroit, was unsuccessful in a similar case.

In a man, in whom he had five years previously ligated the femoral artery, Dr. T. G. Morton, of this city, in 1878, excised an inch and a quarter of the sciatic nerve. Six weeks subsequently the leg had diminished in size rather more than one-half, and the skin had resumed its natural appearance. As the patient died of pulmonary phthisis at the expiration of five months, it is impossible to determine whether the operation would have resulted in permanent relief; the limb at the time of death had regained its functions, and the continuity of the nerve was found to be reëstablished.

When the diseased mass is very large, greatly incommoding by its weight and bulk,

and entirely unamenable to treatment, the only resource is removal with the knife.   If it occupy a limb, amputation will be both safe and easy; but if it involve the scrotum, penis, or pudendum, excision may not only be very difficult, but exceedingly perilous, life being endangered, in the first instance, by shock and hemorrhage, and afterwards by erysipelas, pyemia, and exhausting suppuration.   Undue loss of blood may, under such circumstances, occasionally be prevented by elevating and firmly compressing the tumor prior to the operation.   In a case of Arabian elephantiasis in charge of Professor Briggs, of Nashville, in 1875, the limb, removed at the hip-joint, weighed eighty-eight pounds.

The treatment of the nævoid form of the disease must be conducted upon the same general principles as that of ordinary elephantiasis.   The result is usually unsatisfactory.

SECT. VIII.—MORBID GROWTHS.

The skin is liable to a great variety of morbid growths, some of a benign, others of a malignant nature.   The ordinary sebaceous tumor and the molluscous tumor have their seat in the sebaceous follicles.   Lupus is composed of granulation tissue.   The hard and soft fibromas, and keloid are derived from the connective tissue of the cutis, and sarcoma represents embryonic connective tissue.   Of the neoplasms, which are derived from the higher tissues, myoma and neuroma are very uncommon, and angioma is discussed in the chapter on affections of the capillaries.   The epithelial formations include warts, moles, corns, horns, and epithelioma.   Primary scirrhus and encephaloid carcinoma are, so far as I am aware, never met with in the skin.

1. SEBACEOUS TUMORS.

The sebaceous tumor, essentially consisting of an enlargement of a sebaceous gland with the retention of its secretion, has been described under various names, founded either upon the character of its walls, the fancied nature of its contents, or the kind of structure in which it originates, as encysted, atheromatous, meliceric, steatomatous, and follicular. Wen was the familiar appellation by which it was known by the older surgeons.

The manner in which such a tumor is formed is easily explained.   The first link in the morbid chain is the obstruction of a sebaceous gland or cutaneous follicle, either in consequence of adhesive inflammation, or of the inspissated condition of its own secretion, thereby offering a mechanical impediment to its escape.   The matter, thus forcibly retained, gradually increases in quantity, and as it does so it necessarily presses everywhere upon the walls of the gland, which, in time, expands into a strong sac, varying in size from a pea up to a small orange.   A good illustration of this class of morbid growths, as it occurs upon the scalp, is afforded in fig. 244, from a preparation in my private collection.

Fig. 244.

The contents of the sebaceous tumor are extremely variable, both in color and consistence: in general, however, they are thick and whitish, looking and feeling very much like a mass of lard or tallow; occasionally they present the appearance and consistence of honey; and cases are met with in which they bear a very close resemblance to putty, or a thick mixture of flour and water.   Sometimes the contents of a tumor of this kind are thin, watery, or oleaginous, and exceedingly offensive.

The sebaceous tumor is sometimes filled, either partially or completely, with calculous matter, consisting of phosphate and carbonate of lime, cemented together by a minute quantity of animal substance.   A case has

Sebaceous Tumors of the Scalp, one of them being laid open to show its Cyst and Contents.

been recorded in which the integument of the buttocks was completely studded with small collections of this description, evidently seated in the skin follicles.   Similar formations have been observed on the forehead, scalp, nose, shoulders, trunk, and scrotum.

The cyst of the sebaceous tumor is greatly influenced by age, being generally very thin, soft, and delicate in recent cases, and nearly always very thick, tough, and fibrous in old ones; occasionally, indeed, fibrocartilaginous, fibroplastic, or even calcified.   Externally

the cyst is rough, and more or less intimately adherent to the surrounding parts, while internally it is smooth and glistening, not unlike the inner surface of the dura mater. Small sacs are sometimes observed in its interior, and I have occasionally seen indistinct partitions thrown across it, so as to give it a kind of multilocular appearance.

The sebaceous tumor is free from pain, has few vessels, and is generally very tardy in its development, except when the cyst remains for a long time uncommonly thin, when it may be quite rapid. I have never known it to manifest any malignant tendency, although occasionally it inflames, suppurates, and even ulcerates, and becomes the seat of a very fetid discharge. Under these circumstances granulation tissue may spring up from the inner surface of the cyst, and give rise to an irregular fungous mass which simulates malignant disease, as in fig. 245, from Bryant. It originally occupies the substance of the skin, but, as it increases in size, the cyst gradually pushes its way through, so that the connection between them is ultimately completely lost. Meanwhile, the skin itself is remarkably attenuated, and often, in great measure, deprived of hair, especially on the scalp, where, particularly in cases of long standing, the surface is frequently very hard. Here, too, the steady, persistent pressure of such a tumor occasionally indents the skull.

The degree of mobility of the morbid growth is extremely variable, depending upon its age and volume, but, above all, upon the amount and laxity of the connective tissue in the structure in which it is developed. Its shape is almost globular, except when it is subjected to considerable pressure, when it is always more or less compressed or flattened. Its most common sites are the face, forehead, and scalp. It is also met with on the neck, eyelid, shoulder, back, buttock, and scrotum. I have seen two cases of it on the prepuce of small boys who had been circumcised according to the rites of the Jewish Church. It very rarely occurs on the extremities.

Fig. 245.

Fungating Sebaceous Tumor.

The number of sebaceous tumors, although usually small, is extremely variable. Sometimes there is only one, while at other times there may be as many as five or six on the same person. In one instance, in a man forty years of age, I counted upwards of two hundred, mostly upon the head, face and neck, where they nearly all made their appearance when he was quite young, soon after bathing in cold water. They were of the meliceric kind, the contents of many being visible at the enlarged and partially obstructed follicle, where they had concreted into a yellowish, dirty, wax-like substance. They were of a globular or ovoidal shape, and varied in volume from a pea up to that of a hen's egg. Several cases have come under my observation in which two and even three tumors were inclosed in one cyst.

Childhood and adolescence are the periods of life most liable to these formations. I have met with a number of cases in which they existed either before birth, or came on soon after. They occasionally occur in several members of the same family; and now and then they display an evident hereditary tendency, as in a case under my observation, in which the disease existed upon the scalp of a young woman of twenty-seven, and also upon that of her father, a paternal aunt, and her paternal grandmother. The tumors were, respectively, from four to seven in number, and varied in volume from a marble to that of a walnut. Four other instances of a similar character have come under my notice.

The diagnosis of the sebaceous tumor is sufficiently easy. Its chronic march, indolent character, soft, doughy consistence, mobility, and peculiar situation, together with the absence of enlargement of the subcutaneous veins, and the normal appearance of the skin, always serve to distinguish it from other morbid growths.

The only remedy for this variety of tumor is thorough excision, not a particle of the cyst-wall being left, otherwise there will inevitably be repullulation. When the tumor is situated upon the scalp, a single longitudinal incision may be made across it, the flaps being dissected off from each side, and the morbid mass lifted out bodily, without exposing its contents. In fact, simple enucleation is sometimes sufficient. In most other regions, however, the best plan is to lay the tumor open from within outwards, turn out its contents, and then tear away the cyst. If the integument be diseased, the altered structures should be included in an elliptical incision. When a tumor of this kind has been long subjected to pressure, a tedious dissection is sometimes required to effect its removal. However performed, the operation should never be undertaken without due preparation of the system, as I have repeatedly known it to be followed by erysipelas. On one occasion, I removed a small sebaceous tumor from the back part of the head of a young gentle-

man, the case going on well for the first few days; then erysipelas set in, and in a short time this was followed by an immense carbuncle, which came very near proving fatal. The bleeding after such an operation is usually trifling.

2. MOLLUSCOUS TUMORS.

The molluscous tumor, or molluscum sebaceum of the dermatologist, is so called from its fancied resemblance to the knot so often seen upon the bark of the maple tree. When fully developed, it is about the size of a currant, with a central depression, caused by the peculiar arrangement of its contents. Usually of a round, oval, elongated, pedunculated, or wallet-shape, it is of a soft, spongy consistence, of a red, reddish-brown, or dusky yellowish color, and is most commonly met with in adults and elderly subjects, although children are by no means exempt from it. Occurring upon various parts of the body, as the face, neck, back, shoulders, nates, and extremities, it often exists in such immense numbers as to constitute a veritable molluscous diathesis. From the fact that it sometimes affects several members of the same family, it has been supposed by some to be occasionally contagious, or communicable from one person to another by actual contact; an idea which derives countenance from its rapid and consentaneous development in some of these cases. Of its predisposing and its exciting causes nothing is known. The immediate influence under which it is developed is inflammation of the sebaceous glands, leading to a rapid secretion of their peculiar fluid, which, accumulating in their interior, presses their walls asunder, and gives them a lobulated appearance, as is rendered evident on a section of them. Dr. Beale is of opinion that the growth essentially consists in an alteration of the hair follicles and hypertrophy of the dermoid tissues.

The contents of the molluscous tumor are made up mainly of epidermic scales, in union with ovoid, oblong, or cuboid cells, heaped together like a pile of eggs, and occupied either by granular matter, oil globules, or a peculiar homogeneous, undetermined substance.

Left to themselves, molluscous growths are very liable to pass into ulceration, generally beginning at their summits, and gradually progressing until their contents are completely discharged, when the parts usually readily heal. Occasionally they are invaded by gangrene, which may extend so deeply into the subjacent tissues, as to lead, in the event of recovery, to disfiguring scars. Finally, cases occur in which the tumors are atrophied, or transformed into little pendulous wart-like excrescences.

The *treatment* is best conducted with topical stimulants, of which the most efficacious are tincture of iodine, acid nitrate of mercury, sulphate of copper, chloride of zinc, and chromic acid, all more or less diluted, the object being to produce a sorbefacient rather than an escharotic impression. It will generally be found that brushing the surface of the tumor freely once a day with tincture of iodine will not only promptly arrest its development, but rapidly promote its removal. Laying open the morbid growth, and touching the raw surface slightly with solid nitrate of silver, is sometimes very beneficial. The most expeditious method of all, however, more especially if it has a narrow pedicle, is to cut it away with the knife, or to strangulate it with the ligature.

Constitutional treatment is not to be neglected. Occasionally the molluscous tumor disappears, in great degree, if not entirely, simply under the influence of a change of air, a judiciously regulated diet, and attention to the bowels and secretions. When the general health is much disordered, it should be amended by suitable remedies. Cleanliness is of great importance. When there is a scorbutic state of the blood, iron and quinine, with subacid drinks and vegetables, are indicated. Arsenic has sometimes been serviceable in the earlier stages of the disease.

3. LUPUS.

Lupus belongs to the class of granulation tumors, and arises from an independent growth of small cells around the vessels of the cutis. In its earlier stages, the epithelial cells of the sebaceous and sudorific glands proliferate as the result of the irritation to which they are subjected by the accumulation of clusters of germinal cells in their immediate vicinity. Hence Rindfleisch declares that the affection is an adenoma of the sweat and sebaceous glands. As it progresses, however, and the infiltration of the cutis increases, those structures disappear.

Under the term lupus are comprehended two varieties of disease. In the first, which is known as non-exedent lupus, the granulation tissue extends throughout the entire integument, and, undergoing the fibroid transformation, converts the skin into cicatricial tissue. In the second form, or exedent lupus, the small-celled infiltration breaks down,

and the skin and adjacent tissues are destroyed by rapid ulceration. The two affections are, therefore, identical; the only difference being that the non-exedent variety is milder than the other, more tardy in its progress, and not characterized by loss of tissue. The term lupus, signifying wolf, is suggestive of the destructive tendency of the exedent variety.

1. The *non-exedent*, or erythematous, lupus begins as a circumscribed, roundish, swollen, red, or violaceous patch, which is covered by fine grayish or yellowish scales of exfoliating epidermis. The patch slowly spreads over a large extent of surface, and as it increases, the older portions contract, and induce deformity of the features and stiffness in their movements, when it occupies the face, which is its ordinary seat. The altered skin may remain red, and look like a thin cicatrice; or the centre of the diseased area may become polished, of a livid-white color, and dense and hard, feeling like the rind of bacon, and be surrounded by bluish-red nodules or tubercles, of a soft consistence, and covered with epidermic desquamation. These nodules indicate the further extension of the disease.

Erythematous lupus generally comes on without any assignable cause, and soon exhibits its peculiar features. It is commonly supposed that a scrofulous state of the constitution predisposes to its occurrence, and this is probably true, although in a much less degree than has been imagined. My experience certainly does not warrant the conclusion that the origin of the disease has generally any such relation; in most of the cases that have come under my observation, the patients seemed to be peculiarly free from strumous taint, both as it respected the actual state of their own system, and everything like hereditary transmission. Persons of a delicate, ruddy complexion, with light hair, blue eyes, and an unusually active capillary circulation, are most prone to the disease. How far a syphilitic taint of the constitution may act as a predisposing cause of lupus has not been ascertained; unfortunately, it is seldom in the power of the practitioner to obtain a sufficiently accurate account of his cases to enable him to trace, in a satisfactory manner, their various relations.

Although this variety of lupus may occur in any part of the body, it manifests a peculiar predilection for the nose, cheeks, and eyelids, especially the latter. It seldom appears before puberty; and is most common in females after the age of forty. The general health usually remains good; but the altered skin is occasionally the seat of itching or burning pain.

In the treatment of this variety of lupus, none but the mildest and most soothing applications should be employed. The one from which I have derived most benefit is the dilute tincture of iodine, which, while it changes the action of the secernent vessels, promotes the removal of the granulation tissue, and serves as a protective against atmospheric and other injurious impressions. Brushing over the part once every three or four days with a mixture of collodion and glycerine often answers a good purpose; and benefit has also been derived from the application of sapo viridis, tar and mercurial ointment, naphthol, and a mixture of twenty grains of crysophanic acid to the ounce of cosmoline. If under these measures the patch enlarges and its area is limited, it may be scarified, excised, scraped away, or destroyed with the thermo-cautery.

Along with these topical remedies, special attention must be paid to the state of the general health, which is often not a little disordered. The diet should be light, simple, unirritant, and chiefly, if not exclusively, of a vegetable character, the drinks consisting of water, milk, or weak tea; the bowels and secretions should be regulated with blue mass and ipecacuanha, or blue mass and colocynth; and, if signs of debility exist, tonics should be resorted to, in combination with alterants, of which the best are quinine and iodide of iron, with a minute quantity of bichloride of mercury and arsenious acid. Of late, very favorable mention has been made of the use of the chloride of arsenic in the treatment of this affection, in doses varying from eight to fifteen drops thrice a day, and a number of cases illustrative of its beneficial effects have been reported. Of its efficacy, however, I can say nothing from personal experience. When the vital forces are much impaired, cod-liver oil and milk punch must be pressed into the service.

2. The *exedent* lupus, often described as the serpiginous ulcer of the face, generally begins either as small, hard, white, shining tubercles, or as a fissure, crack, or excoriation, with indurated edges, and a thin, brownish incrustation. In either case, it soon exhibits its characteristic tendency to spread, not in depth, but circumferentially, for it rarely, at least in its earlier stages, penetrates beyond the substance of the true skin, or even far into that. In fact, it is essentially a superficial ulcer, passing generally from one point to another, but seldom involving the deeper structures, except, perhaps, when it appears on the ala of the nose, where it occasionally evinces a highly erosive disposition. When it effects the eyelids, it may, in time, extend to the fibres of the orbicular muscle, and

even to the tarsal cartilage, but, in general, it remains limited for years to the skin, or skin and connective tissue. The parts around the ulcer are hard, puckered, tender, and usually somewhat reddish, although very often they retain their normal color. The ulcer is the seat of occasional, darting, stinging, or shooting pain, and of more or less itching, generally much more disagreeable than the pain itself. When the crust, which is usually very thin, and of a brownish or blackish color, drops off, it is speedily succeeded by another of a similar kind. When the surface is thus exposed, it is occasionally found to be covered by very red, sensitive granulations, smeared over with thick, yellowish, viscid pus, and disposed to bleed on the slightest touch. The edges of the ulcer are usually steep, jagged, and slightly everted. As the sore spreads in one direction, it often heals in another, leaving a yellowish, hard, and shrivelled scar, strikingly contrasting with the surrounding parts.

The exedent variety of lupus is most common before puberty, a feature which, when considered in connection with its liability to coexist in several regions of the body, and the absence of hard, everted edges, serves to distinguish it from epithelioma. The probability is that writers often confound this affection with the effects of a syphilitic taint of the system, exhibiting itself in the form of one or more superficial, foul, obstinate ulcers, which, when the diagnosis is properly understood, always promptly disappear under the use of iodide of potassium and bichloride of mercury.

In the treatment of exedent lupus the same general remedies are indicated as in the erythematous variety. Of local measures the caustic agents are always required to arrest the progress of the disease and to set up a healthy action. Of late years I have been in in the habit of scraping away the diseased tissues, and immediately applying to the raw surface either the ethylate of sodium or Esmarch's powder, which is composed of one part each of arsenious acid and muriate of morphia, eight parts of calomel, and forty-eight parts of powdered gum arabic. When the eschar drops off, cicatrization is promoted by a slippery-elm poultice or water dressing.

4. FIBROUS TUMORS.

1. *Hard fibromas.*—Circumscribed fibromas, composed of compact fibrillar connective tissue, are occasionally met with in the cutis, especially in young adults; they usually come on without any assignable cause, are always very tardy in their development, and are free from malignancy. The most common site of circumscribed hard fibromas of the skin are the neck, chest, and shoulder, but they may occur at all points of the body, even upon the fingers and toes. Varying in size in different cases, they seldom exceed, when attention is first called to them, the volume of a hazlenut or an almond; they are of a firm consistence, dense, and inelastic, creaking under the knife, and exhibiting, when divided, a homogeneous appearance not unlike that of an unripe pear or turnip, with but little evidence of vascularity. Their surface is generally smooth, or slightly fissured, pervaded by small straggling vessels, and somewhat lighter than that of the skin in the substance of which they are developed. Movable at first, they manifest a disposition, as they increase in bulk, to extend into the subcutaneous connective tissue, to contract adhesions, and to become affected with sharp, darting pains, seldom, however, so severe as to cause much annoyance. In time, a process of disintegration may be set up in them, eventuating finally in ulceration, especially if the part is habitually fretted or compressed. The general health never suffers.

In the treatment of these tumors nothing is to be expected from sorbefacient remedies. So long as they remain inactive, or are so situated as to occasion no inconvenience, they may be let alone; when the reverse is the case, they should be extirpated.

2. *Keloid.*—The keloid tumor, so called from its fancied resemblance to a crab, is also a peculiar hard fibroma of the cutis, first accurately described by Alibert, in his treatise on cutaneous diseases, in 1810. It is characterized by the existence of hard, semielastic, prominent ridges, of a cylindrical or rounded form, more or less discolored, and the seat of an unpleasant itching sensation. Processes, roots, or branches usually extend from it into the neighboring parts, the whole looking very much like the cicatrice of a burn.

The disease is generally described as being extremely infrequent; but, judging from my own experience, this is not the fact. I have notes of at least thirty cases, and many more have come under my observation of which I have neglected to keep a record. It occurs in all grades of society, in both sexes, in nearly all parts of the body, and at almost all periods of life. I have seen it at three years and a half, and repeatedly after the age of sixty. A number of my patients were negroes; but whether they are more subject to the disease than whites I am unable to affirm, although this is highly probable.

The exciting causes of keloid are not always the same. It sometimes arises spontaneously, and is then very liable to show itself in various parts of the body, as if the individual was laboring under a veritable keloid diathesis, as in two remarkable examples under my observation. In general, keloid succeeds to some local injury, sometimes of a severe, but more commonly of a trivial, character, as a scratch, puncture, or abrasion. In four of my cases it supervened, respectively, upon the operation of cupping, the application of a blister, the contact of nitric acid, and the cicatrices left by smallpox. In another instance it broke out upon a vaccine scar. In a young lady of seventeen, it was produced by the application of hydrate of potassium, employed for destroying an enlarged lymphatic gland of the neck. In several cases it followed upon the extirpation of tumors. Thus, in an elderly lady from whom I removed the right mammary gland, two well-marked keloid growths came on, soon after the operation, at the site of two small incisions made to ease one of the flaps with a view to more accurate approximation ; and the occurrence of the disease after the ablation of keloid tumors, both at the line of union of the edges of the wound and at the parts transfixed by the pins used for the twisted suture, is familiar to every surgeon. The most common causes, however, of keloid, so far as my experience extends, are burns and scalds, and I have also seen a considerable number of cases in which the disease was directly traceable to the irritation produced by wearing a bad form of ear ring. Young negresses are particularly prone to suffer from this source.

The period which intervenes between the occurrence of the exciting cause and the actual development of the disease is altogether uncertain ; in many cases it is very short, not exceeding a few weeks, or, at furthest, a few months ; on the other hand, however, the time is occasionally much longer. In several of my cases the tumors had acquired a large bulk in the space of a single year. Once fairly commenced, the disease generally proceeds with marked rapidity, especially when it is traumatic ; the same is also true, although not so generally, when it arises spontaneously. Thus, in an instance recently under my observation, an immense number of these excrescences appeared spontaneously upon different parts of the body within a few months after the first manifestation of the morbid action.

The peculiar external characters of keloid will readily be understood from the annexed drawing, fig. 246, taken from a patient of mine, a colored man upwards of fifty years of

Fig. 246.

Keloid Tumors.

age, whose body was literally covered with growths of this kind. They were particularly numerous on the neck and trunk, both in front and behind, and also on the shoulders and arms, while the forearms, hands, and lower extremities were entirely free from them. In size they ranged from a small Lima bean up to that of a sausage from six to eight inches in length. They were of all shapes ; some round or cylindrical, some elongated and flattened, some angular, some crucial, some crablike or full of processes, roots, or prongs; in short, nature seemed to have exhausted her ingenuity in devising figures for their representation. The surface of nearly all was rough, wrinkled, or puckered. Most of them projected from a line and a half to an inch and a quarter above the surrounding level ; some were isolated, others ran into each other, thereby adding still further to their grotesque appearance. Their consistence varied ; most of them were remarkably hard and firm, feeling very much like a mass of fibro-cartilage, with a slight

degree of the elasticity inherent in that tissue. In regard to their color, while some resembled the natural skin, the great majority were several shades lighter. The inter-

vening integument was sound up to the very borders of the keloid tumors, which were all distinctly circumscribed, and, with the exception of a very few, slightly movable.

The disease had begun early in life, but had for years been almost stationary. The man was otherwise well conditioned, his general health having all along been excellent; the only annoyance which he experienced was an itching or stinging sensation in some of the tumors, which, although at times very severe, especially when he labored under constipation, dyspepsia, or accidental overheating of the body, did not materially interfere with his sleep and other enjoyment.

In another case of spontaneous, universal keloid disease, in a young gentleman, eighteen years of age, a native of Cuba, the general health had always been excellent until twelve months previously, and there was no hereditary taint of any description. The tumors were, for the most part, of a rounded or oval shape, not very hard to the touch, movable, vascular, of a dusky reddish hue, free from pain, and quite tolerant of manipulation. In a few situations they formed distinct ridges, from a line to an inch in width, projecting prominently beyond the level of the surrounding surface. The hands and feet were covered with them, particularly the joints of the fingers and toes; they were also found on the legs, knees, buttocks, right arm, and elbow. The general health was somewhat impaired, the youth looked dyspeptic, and he labored under partial paralysis of the left superior extremity.

In white persons the keloid tumor is generally a few shades redder than the adjoining skin; occasionally, indeed, it has a very fiery appearance, and is pervaded by numerous, delicate, superficial vessels, in a state of habitual congestion.

A distinction has been made between keloid tumors by separating them into two varieties, the true and the spurious. The former, it is alleged, arise spontaneously, whereas the latter are always caused by some local injury. Such a division, however, is altogether arbitrary, inasmuch as the structure in both of the so-called forms of the disease is perfectly identical.

Keloid rarely, if ever, degenerates into malignancy. Of all the cases that have come under my notice, not one exhibited such a tendency. When excised, however, it nearly always speedily returns, rising, like a phœnix, with increased activity, from its ashes; so that the second state is generally much worse than the first. In some cases the tumors remain completely stationary for a long time, while, in others, they gradually advance until they have acquired a considerable bulk, when they usually become passive, and so continue for many years. Occasionally, in consequence apparently of prolonged pressure or local irritation, they take on ulcerative action.

In regard to their structure, keloid formations belong to the class of fibrous growths, described in the chapter on tumors, although an example is now and then met with in

Fig. 247.
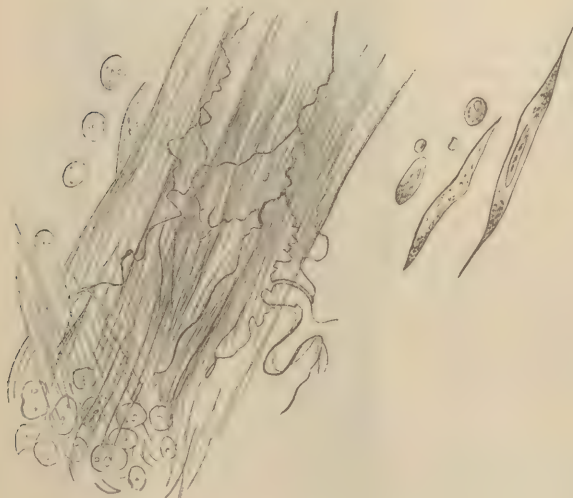
Microscopical Characters of Keloid.

which the minute structure is very similar to that of spindle-celled sarcoma. According to Dr. J. C. Warren, of Boston, whose investigations have been confirmed by Dr. Neumann, of Vienna, they are developed from the walls of the small arteries of the cutis, and, in consonance with the arrangement of these vessels, the fibres of the tumor are all more or less parallel to its long axis. The tendency which they manifest to recurrence after extirpation is doubtless due to the formation of spindle cells in the external coat of the arteries, a change which extends for some distance beyond the limits of the morbid mass. The tumor, on section, presents to the naked eye a whitish, homogeneous aspect, or, if the mass is old, very much the appearance of an unripe turnip. It creaks slightly under the knife, and is of a dense, firm consistence, with very little elasticity. Hardly any vessels are perceptible in its in-

terior, but the surface of the growth is usually, as already stated, quite vascular, the vessels passing over it in distinct lines, more or less tortuous and varicose in their arrangement. The minute structure of keloid is well seen in fig. 247, drawn from one of my specimens by Professor Da Costa.

The *treatment* of keloid is altogether unsatisfactory. So far as I know, there is no remedy which exercises the slightest influence in arresting its progress or promoting its removal. Sorbefacients and alterants of every description, in every form of combination, and in every variety of dose, have been employed, and yet I am not aware of a solitary instance in which their exhibition, however protracted, has been followed by a cure. The different preparations of iodine, arsenic, chloride of barium, chloride of ammonium, and kindred articles, so serviceable in some other morbid growths, have all signally failed in effecting any beneficial change in this. The excessive itching, burning, or stinging, which is a source of such annoyance when the tumors are large or numerous, is best relieved, according to my experience, by a proper regulation of the diet, an occasional active purgative, the exhibition of the antimonial and saline preparations with Fowler's solution of arsenic, and the frequent use of the tepid bath, either simple, or medicated with carbonate of sodium or potassium, salt, or bran. Anointing the tumors occasionally with oil, glycerine, or mild pomatum will also prove serviceable. Benzoated zinc ointment, or an ointment composed of camphor and chloral, often affords great relief. Everything like pressure or local irritation must be carefully guarded against. If ulceration arise, only the most soothing remedies should be employed.

As to excision, my experience is decidedly opposed to it. In the many cases in which I have tried it, signal failure has been the result, the disease always recurring at the site

Fig. 248.

Molluscous Fibroma.

of the cicatrice in a short time, in some cases, indeed, as I know from ample personal experience, within the first four or five weeks. It is only when the tumors act obstructingly, as when they impede the opening of a natural outlet, or become a source of great disfigurement, that interference should be considered as warrantable. Possibly in some cases relief might be afforded by a plastic operation, but of this I am not able to say anything from personal experience.

In a case of an immense keloid tumor, encircling the neck, and causing serious inconvenience by its pressure, in a negro, twenty-eight years of age, an inmate of the Philadelphia Hospital, the late Dr. F. F. Maury succeeded, after three separate operations, in effecting complete riddance with the écraseur, the entire mass weighing nine pounds. A number of similar growths existed in other parts of the body. The man recoved without a single accident.

3. *Soft fibromas.*—Under the term *molluscous fibroma*, Virchow has described a form of cutaneous fibrous tumor, in which the growth, composed of a soft, very succulent, loose connective tissue, as in fig. 248, from that author, appears

Fig. 249.

Molluscous Fibroma.

to be derived from the fibrous structure of the papillæ. Varying in size from a millet seed to that of an adult head, the smaller ones are made up of round and spindle-celled tissue, while the larger tumors are composed of soft, poorly organized, fibrous tissue. The former are seated principally in the superficial layer of the cutis, from which they may readily be enucleated. Soft, almost to the point of fluctuation, they are generally multiple, covering the entire body, although their favorite seats are the face and trunk, giving rise in the former situation to the affection described by the older authors as leontiasis. Occasionally congenital, they are free from pain, not contagious, little disposed to ulcerate, and tardy in their development.

In its multiple form, molluscous fibroma induces general nutritive disturbances, which lead, in the course of time, to death from inanition. Its analogy to nodular elephantiasis of the genital organs is very great, the only difference being that the progress of the former is unattended with fever and local inflammation. The accompanying sketch, fig. 249, from a photograph of a Chinaman, kindly sent to me by Dr. J. G. Kerr, of Canton, affords an excellent illustration of this affection.

The treatment of these tumors does not differ from that prescribed for the ordinary fibrous growth. When they produce unsightly deformity, or occasion much inconvenience, they may be excised.

5. SARCOMATOUS TUMORS.

These tumors are uncommon in the skin. Occurring most frequently after the fortieth year, they are usually of the spindle-celled variety, and begin as a smooth, firm, elastic, reddish, or violaceous nodule, although they are occasionally ingrafted upon a mole, wart, or cicatrice, grow rapidly, and may attain a considerable bulk, at length ulcerating and becoming the seat of a more or less abundant and fetid discharge. No involvement of the lymphatic glands takes place, and the general health does not suffer unless the growth assumes malignancy. Recurrence is common after extirpation.

A case of round-celled sarcoma lately under my care, in a lady seventy-two years of age, very well illustrates the clinical nature of this affection. The tumor, about the size of a common orange, occupied the inside of the middle of the forearm, where it was first noticed about five months before, as a small, hard, movable lump. It rapidly enlarged, and in a short time assumed an angry and inflamed appearance, the skin giving way at several points, followed by a thin, sanious, offensive discharge, which eventually became very abundant and irritating to the surrounding surface, which, to an extent of several inches, was habitually red, tender, and deeply congested. There was occasionally a little shooting

Fig. 250.   Fig. 251.
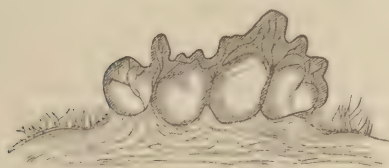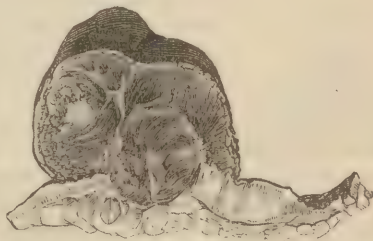
Verrucous Sarcoma.   Nodule of Melanotic Sarcoma in the True Skin.

pain in the tumor, but the health was excellent, and the axillary lymphatic glands were perfectly sound. A section of the tumor after removal was found by Dr. Keen to be composed chiefly of small round and oval cells, with multiple nuclei, and with a moderate amount of friable, filamentary intercellular substance. The wound, which was only skin deep, healed very kindly, and up to the present time, some months after the operation, there is no evidence of recurrence. Verrucous sarcoma, which presents itself as an aggregation of enlarged papillæ, incrusted with an epithelial covering, as in fig. 250, from Lücke, is usually composed of small round cells.

Pigmented or melanotic sarcoma of the skin, fig. 251, nearly always coexists with melanosis in other parts of the body. In a case that was under my observation, some years ago, in a man, aged fifty-eight, it involved nearly all the principal organs, and, of course, finally proved fatal. In another instance, which I saw in the practice of the late Dr. George McClellan, an immense number of melanotic tumors existed in the skin and connective

tissue of the abdomen, varying from the volume of a small pea up to that of a mass the size of a large almond; they were of a firm, fibro-cartilaginous consistence, slightly movable, exquisitely painful, and of a bluish-black color. The remedy in this case was excision, a few of the larger tumors being removed at a time; the operation was repeated every ten or twelve days, for several months, when, as but little progress had been made towards a cure, the patient became discouraged, and declined further interference. He finally died, completely exhausted by the disease.

When melanotic sarcoma is confined to the integument, and occurs as a circumscribed tumor, the proper remedy is early and free excision; but under opposite circumstances, or when it coexists in other parts, or is extensively diffused through the cutaneous and connective tissues, all interference of this kind should be avoided, as likely to accelerate the fatal crisis.

6. MYOMATOUS AND NEUROMATOUS TUMORS.

1. MYOMA of the skin, composed of smooth muscular fibres, has occasionally been observed, as single or multiple growths, in the scrotum, nipple and its areola, trunk, extremities, penis, and labia. It is usually pedunculated; is smooth, hard, and of a rosaceous tint; varies in size from a pea to an orange, being generally of the volume of an almond; and grows slowly, and, as a rule, painlessly. The proper remedy is excision.

2. NEUROMA.—The only cases of neuroma of which I have any knowledge are those of Dr. Duhring and Dr. Kosinski. The tumors were multiple and composed of amyelinic nerve fibres. In the case of Duhring, numerous small, rounded, and excessively painful tubercles were situated upon the shoulder and arm; and excision of an inch of the brachial plexus of nerves, by Dr. Maury, was temporarily followed by diminution of suffering and decrease in the size of the tumors. In the case of Kosinski, the buttock and thigh were affected in a similar manner. Removal of an inch of the small sciatic nerve resulted, at the expiration of four months, in the almost complete disappearance of the nodules and the relief of pain.

7. PAPILLARY TUMORS.

The morbid growths comprised under this appellation include two varieties, the hard and the soft, the first consisting of warts, corns, and horns, and the second of moles and condylomas, or the excrescences situated about the anus, on the head of the penis and on the vulva, in connection with which organs they will be described.

1. WARTS.—Warts, or verrucous growths, are those peculiar excrescences, or prominences, so often seen upon the hands and face of young persons, although the old are by no means exempt from them. They are outgrowths of the papillæ of the skin, which are collected into a circular group, as seen in the adjoining sketch, fig. 251, from Follin, and covered with indurated epidermis. The intervals between the individual papillæ are occupied by a large number of transitional cells of the mucous layer of the epidermis. The vessels of the papillæ are enlarged and extend close up to their extremities. They sometimes occur in such numbers as to constitute a genuine verrucous diathesis. When this is the case, they are not only developed with remarkable rapidity, but are apt to attain an extraordinary size. A very painful and disagreeable wart occasionally forms under the nail, either in front or at the side. It occurs both on the fingers and toes, although much more frequently on the former than the latter. Of the exciting causes of warts nothing is known: they are often met with in several members of the same family, and instances are observed in which they betray a hereditary tendency.

Fig. 252.

Common Wart.

A wart is a hard, insensible excrescence, generally of a conical shape, more or less movable, and attached by a broad base, although sometimes the reverse is the case, the union being effected by a very narrow pedicle; its surface is rough, fissured, or tuberculated, and usually a few shades darker than the adjacent skin; its size seldom exceeds that of a common pea. When cut, it is painful, and bleeds somewhat. The fluid which follows a section of a body of this kind has been supposed, but erroneously, to be contagious, or inoculable. A wart of the face, arm, or shoulder sometimes becomes the seat of carcinoma, or sarcoma, especially when it is constantly rubbed or irritated.

The treatment of warts is very simple. In young persons, in fact, they often disappear spontaneously. The best local remedy is chromic acid, with equal parts of water, applied with a glass brush. It instantly turns the skin black, and forms an eschar, which drops

off in six or eight days, leaving a healthy, granulating sore, which soon heals. Tincture of iodine, acetic acid, dilute nitric acid, and sulphate of copper, also answer an excellent purpose. When the excrescence is attached by a very delicate pedicle, riddance is easily effected with the ligature or scissors. The verrucous diathesis is best counteracted by the exhibition of arsenic, or Donovan's solution. Excision is necessary when a wart displays a tendency to malignancy.

2. CORNS.—Corns, or clavi, consist in a circumscribed indurated overgrowth of the horny layer of the epidermis, the central portion of which is directed inwards towards the papillæ. They are caused by irritation of the superficial portion of the dermis and hypertrophy of the papillæ; affect different parts of the toes and feet; and are generally produced by wearing tight shoes and boots, whereby these organs are habitually compressed and even forced out of their natural position. A short, tight stocking occasionally produces a similar result. Corns are very variable in regard to their size, form, and consistence. They are usually distinguished into hard and soft.

Hard corns are dry, scaly, insensible callosities, occurring mostly on the dorsal surface of the toes, opposite the middle joints. All these structures are occasionally affected, but the great and little toes suffer much more frequently than any of the rest. These bodies are met with also in the sole of the foot, in the hollow or arch, and on the under part of the heel. Occasionally a very hard corn is found under the nail of the big toe, or between the nail and the fleshy part of the toe.

A hard corn, when fully developed, is lamellated, firmer at the centre than at the periphery, and furnished with a kind of central nucleus, core, or blunt cone, of a whitish, horny appearance, not unlike the eye of a fowl. A small, but distinct burse, containing a minute quantity of serous fluid, and sometimes a drop of blood, is almost always interposed between it and the dermis, the papillæ of which are depressed, diminished in number, or entirely destroyed. These apppearances are well shown in the adjoining sketch, fig. 253, from Follin. The hard corn consists of many layers with their convexities turned downwards; it is commonly of a circular shape, is either fixed or movable, and varies in size from the head of a pin to that of a dime. In many cases it has a kind of radiated root.

The hard corn, from a continuance of the pressure by which it is produced, becomes gradually a source of pain and tenderness, which are much increased by exercise, and are often accompanied by heat and swelling of the whole foot. In time the burse under the horny cuticle inflames, and pours out an unusual quantity of fluid, which distends the sac, and thus greatly aggravates the suffering. When matter forms, the pain becomes excruciat-

Fig. 253.

Structure of a Corn.

ing, the slightest touch is intolerable, and the patient is unable to use the limb. In such cases the lymphatic vessels are sometimes inflamed as high up as the groin.

Soft corns are always situated between the toes, usually opposite a joint or at their angle of union, and derive their characteristic features from being in a constant state of moisture, from the perspiration which collects between these parts; they are usually superficial, and are produced by wearing narrow-soled shoes, by which the toes are habitually squeezed together, bent at their articulations, or forced over or under each other. For this reason ladies are more subject to this variety of corn than men or the poorer classes of females. The soft corn is of a circular or oval figure, of a whitish, yellowish, or grayish color, with a radiated or horny-looking nucleus, and is seldom larger than a split-pea or half a dime. Occasionally it is broad, oblong, flat, and of a dark color, from the presence of extravasated blood. In some instances, especially in old people and in cases of long standing, the corn is very hard at the centre, has a small synovial burse, and consists of several distinct layers. From being constantly compressed, it is very painful, and remarkably prone to inflammation, suppuration, and even ulceration.

The *treatment* of corns consists in scraping away the thickened cuticle, and lightly touching them with nitrate of silver, or tincture of iodine, repeated occasionally until the cure is completed. This may be greatly expedited by washing the feet night and morning with cold water and soap, and afterwards rubbing them well with a soft, dry towel. The shoe, which should have a low, broad heel, should be accurately adapted to the shape of the limb, and all undue pressure carefully avoided, even from the seam of the stocking. When the toes are much deformed, or incurvated, they are to be kept apart by pledgets of lint, a piece of soft sponge, or strips of adhesive plaster passed from one to the other. When this cannot be done from their fixed position, amputation may become necessary. In

some instances it is useful to make the patient wear a stocking constructed on the principle of a glove, each of these stockings having a separate stall. A shoe made of buckskin or cloth sometimes affords great relief.

When corns are very tender, they should be frequently scraped with a blunt knife, and kept constantly covered with a piece of soap plaster, or a bit of linen spread with simple cerate to prevent them from becoming hard and dry. In some instances the pressure may be warded off by letting the corn project through a hole in the plaster, which ought then to be very thick, or consist of several layers. When the corn is seated in the sole of the foot, and this treatment is employed, it must be first covered with a piece of adhesive plaster, otherwise the weight of the body will cause the skin to project into the opening, and thus produce severe pain in walking. Occasionally it is necessary to cut a hole in the boot or shoe, or to wear a felt sole with a hole in it, to protect the corn from pressure and friction. All these means, however, are merely palliative, and, when they fail, nothing short of complete eradication will answer. The operation, which is seldom painful, is performed with a small narrow-pointed scalpel and pair of forceps, care being taken not to injure the sensitive skin beneath, and to soften the corn by previous immersion in warm water. When an abscess forms, it should be opened as speedily as possible, after which the offending part may be removed, or this may be postponed to another day. Sometimes the matter escapes by ulceration, leaving a fistulous sore with thick, irregular edges, and constantly bathed with a thin, ichorous fluid. In such a case nitrate of silver constitutes the best remedy.

When corns are inflamed, they cannot be treated with too much care, since, if neglected, they may give rise to serious mischief. The foot should be kept perfectly at rest, and it may even be necessary to resort to leeches and medicated fomentations. The knife should be used most cautiously. Several instances have fallen under my observation in which the cutting of an inflamed corn was followed by violent erysipelas and mortification ; and numerous cases are recorded in which these diseases, thus occasioned, have caused death.

Fig. 254.

Horny Excrescence growing from the Scalp.

3. HORNS.—The horny tumor, or keratoma, is met with principally in those regions of the body which abound in papillæ and sebaceous follicles, as the face and forehead. Of seventy-one cases collected by Villeneuve, not less than thirty-one occurred in these situations. They have been found on the lips, the ear, the penis, and the scrotum. I have in a number of instances seen well-marked horn-like excrescences on the free extremity of the stump after amputation. Several such growths are sometimes observed in the same person. Although they are most common in elderly subjects, I have met with two cases in children under ten years of age. They seem to occur with nearly equal frequency in both sexes.

The size, shape, color, and consistence of the horny tumor are subject to much diversity, depending on its age, and other circumstances. A length of three to six inches by half an inch to an inch in diameter, as in fig. 254, is by no means uncommon. In the British Museum there is a growth of this description, eleven inches in length by two and a half in circumference; and examples of a still more remarkable nature have been reported by authors. In that curious book, An Essay for the Recording of Illustrious Providences, by Increase Mather, are briefly mentioned

the particulars of the case of a "man that has an horn growing out of one corner of his mouth, just like that of a sheep; from which he has cut seventeen inches, and is forced to keep it tied by a string to his ear, to prevent its growing up to his eye."

The shape of these excrescences is usually conical, being larger at their adherent than at their free extremity, which is always somewhat tapering, and their direction is either spiral, twisted, or bent, very much like the horn of a sheep. In a case recorded in the New York Medical Repository for 1820, an enormous growth of this kind, measuring fourteen inches in circumference at its shaft, consisted of three distinct branches. The surface is generally marked by rough, circular rings, indicative of the successive steps of their development. Now and then it is imbricated, knobbed, or covered with small pearl-colored scales. In color the excrescences vary from a dingy yellow to a dark grayish, brown, bronze, or black, according to their age, and the amount of their exposure. They are more or less flexible, and of a firm, fibro-cartilaginous consistence. Their internal arrangement, as seen on a section, is longitudinally lamellated, as in fig. 255.

When burned, these formations exhale a characteristic animal odor. They are chiefly composed of albumen, in union with a small quantity of mucus, phosphate of lime, and chloride of sodium, with a trace of lactate of soda. On the addition of acetic acid, numerous epidermic scales become apparent, with all the characteristic properties of such structures. Under the microscope, the minute texture of these growths exhibits epithelial cells, which, according to Sir Erasmus Wilson, are of a flattened shape, closely condensed, and, here and there, fibrous in their arrangement. They are somewhat larger than those of the epidermis, and possess nuclei, for the most part of an oval shape, their long diameter measuring $\frac{1}{2500}$, the short $\frac{1}{3300}$ of an inch. The average size of the flattened cells is about five times greater than that of the nuclei.

Fig. 255.

A Section of a Horn, showing its Lamellated Structure.

Human horns are generally connected with hypertrophied papillæ, in which they probably take their rise. Their development is frequently directly traceable to the effects of chronic inflammation, or external injury, as a burn, wound, or contusion. When first observed, they are quite soft, semitransparent, and invested by a distinct cyst, which, extending over their base, is gradually and insensibly lost upon their trunk. Very soon, however, they become hard, and, assuming a darker hue, thus acquire the veritable properties of the horny tissue as it exists in the inferior animals. Their growth is always very tardy.

Although these excrescences sometimes drop off spontaneously, a cure rarely, if ever, follows such an occurrence; for, as the matrix remains, it soon becomes the starting-point of a new growth, which, pursuing the same course as its predecessor, may eventually acquire a similar, or even a greater, bulk. The proper remedy is extirpation, the whole of the epigenic cyst being included in two elliptical incisions, the edges of which are afterwards carefully approximated by suture and adhesive strips. When the operation is thoroughly executed, there is no chance of a recurrence of the morbid product.

4. MOLES.—Moles, or fleshy warts, are congenital spots, occurring upon various portions of the external surface of the body, usually of a dark, grayish, blackish, tawny, or brownish color, and closely covered with short, thick, almost bristly hairs. They project somewhat above the surrounding level, are usually a little harder than the natural skin, and are of various forms, of which the round and oval are the most frequent. Some persons are remarkably liable to the formation of moles, and it is then not uncommon to see them scattered over different parts of the body. The face, shoulder, neck, and arms are their most frequent seats. In size they range from a three-cent piece to that of a dinner plate.

These spots are due to pigmentation of the soft mucous layer of the epidermis and of the dermis, with hypertrophy of the latter and its papillæ, and hyperplasia of the hair follicles.

Long-continued local irritation, as that caused by friction, pressure, or want of cleanliness, may occasion ulceration in these bodies, but generally they remain perfectly stationary and innocuous. Not long ago, I excised from the back part of the arm of a gentleman of upwards of eighty a mole which had been a source of annoyance to him for thirty years. It had latterly become ulcerated, had often bled, and was the seat of a very fetid discharge. It was included in an elliptical incision, the parts healing kindly, and there being no return

of the disease. Moles, like healthy structure, may take on malignant action, the most common of which is the epithelial.

Moles only become the subjects of surgical interference when they cause serious disfigurement, or when they pass into ulceration. It has been proposed to get rid of them by mild caustic applications, as Vienna paste, chromic acid, or chloride of zinc ; but as such a procedure might be followed by keloid, the best plan always is to use the knife, the morbid structures being included in an elliptical incision, the edges of which are afterwards healed, if possible, by the first intention.

8. EPITHELIOMA.

Epithelioma of the skin differs from epithelial carcinoma of the mucous surfaces or of the junction of the latter with the integument in being, as a rule, superficial or more disposed to extend along the surface than to infiltrate the deeper tissues. The affection may be divided into two varieties, which differ widely in their clinical features and in the amount of destruction of the structures involved in the morbid action. They are known as cicatrizing epithelioma and rodent ulcer or cancer.

1. The *cicatrizing epithelioma*, a term which is synonymous with fressende flechte of the German authors and with the lepoid of Dr. Warren, the latter name having been applied to it from its resemblance to the bark of a tree, is most generally observed upon the face, nose, and forehead of elderly persons, usually males, of a delicate, florid complexion, with an habitual tendency to congestion of the capillary vessels, light eyes, and light brown, or reddish hair. Although occasionally single, I have more commonly found it to be multiple. In some instances, indeed, quite a number of spots are observed, scattered about in different directions, with intermediate healthy skin. It generally makes its appearance in the form of a small, circumscribed speck, not larger, perhaps, than a mustard seed, and of a dirty, grayish color, which becomes covered with a very rough, brownish crust or scale. This, falling off, is soon succeeded by another, of the same complexion, form, and consistence. Thus the disease is often kept up for many successive years. At last, however, superficial ulceration sets in, and the dermis is converted into a red, glossy, retracting cicatricial tissue, covered with a thin layer of epithelium. The progress of the disease is attended with hardly any pain ; but the patient is generally very much annoyed by itching, leading to an irresistible desire to scratch, which always aggravates it.

The precise derivation of cicatrizing epithelioma is undetermined, although it is highly probable that the morbid action is confined to the superficial stratum of the mucous layer of the epidermis.

The best remedy for this disease is non-interference. The rough, bark-like scale may occasionally be softened with a little dilute citrine ointment, or covered with a mixture of two parts of collodion and one of castor oil, to serve as a defence from the air. All irritating applications must be refrained from. If the disease is inclined to spread, the tissues may be destroyed with the Vienna paste, or removed with the knife, although it will generally be best to avoid all operative interference, as it is likely to aggravate the case by an early recurrence of the formation.

2. *Rodent ulcer*, Jacob's ulcer, cancroid, noli me tangere, flat or superficial epithelial carcinoma, is the phase of epithelioma, which in all probability is derived principally from the external root-sheath of the hair follicles or the involuted continuation of the mucous layer of the epidermis. The cells are smaller than those found in ordinary epithelioma ; they do not evince signs of activity and proliferation ; and they grow into the connective tissue of the cutis in the form of solid, anastomosing plugs or cylinders. When the new structure is fully developed, concentric globules of corneous epithelium are occasionally found in the plugs, as is well represented in fig. 256, from Dr. J. Collins Warren.

Rodent ulcer generally begins in the form of a hard nodule, pimple, or warty excrescence, which, after perhaps an existence of several years, ulcerates superficially and becomes covered with a crust. As the infiltration of the tissues progressively advances, the scab drops off, and leaves an ulcer which has a depressed or excavated appearance, with hard, raised, and rolling edges, and a mammillated bottom, composed of small, indurated granulations. There is little secretion, and at the advancing borders of the sore the orifices of the sebaceous glands, plugged by sebum, are very distinct. The progress of the disease is generally very slow ; or the malady, after having evinced a most destructive tendency, may suddenly stop, with all the appearances of a complete cessation of hostilities. A case has been reported to me where the morbid action, after having destroyed the greater portion of one cheek, with the corresponding antrum, has remained in a state of abeyance

for the last ten years, although it had been steadily pursuing its course for upwards of fifteen. Its march is occasionally remarkably rapid, great mischief being done in a few

Fig. 256.

Vertical Section of Rodent Ulcer—*a*, Stroma—*b*, Epithelial globes.

months, being attended with the most frightful ravages and the most disgusting deformity. Thus, it may consume the whole of the nose, one cheek, the chin, the orbit, and forehead, and even extend to the dura mater and the brain, as in fig. 257, taken from a patient of Mr. Erichsen.

Fig. 257.

The affection progresses by destroying its own margins and by invading the continuous and the contiguous tissues; and as it advances there is often a tendency on the part of the older portion of the ulcer to cicatrize. During its course it appears to obliterate the bloodvessels and the lymphatics, so that the lymphatic glands and the viscera are never the seats of secondary tumors.

Rodent ulcer is a disease of advanced age. It evinces a remarkable predilection for the upper part of the face and head, its favorite situations being the cheek, the side of the nose, the eyelids, and the temple. The pain is generally slight; but now and then it is severe, being of a sharp, biting, darting or shooting character, and liable to temporary exacerbations from exposure, and atmospheric vicissitudes. The general health, at first entirely sound, becomes seriously affected during the progress of the disease; the appetite and sleep are impaired; the

Rodent Ulcer; Perforation of Skull and Exposure of Dura Mater.

strength declines; marasmus gradually ensues; and the patient, worn out by suffering, finally dies completely exhausted.

The great object in the treatment of rodent ulcer is to arrest the morbid action, either with the knife, or with some suitable escharotic, as the acid nitrate of mercury, chloride of zinc, Vienna paste, or Esmarch's powder. Excision, as a rule, deserves the preference. The operation should be performed as early as possible. Sometimes the actual cautery may be employed with advantage, its action being, seemingly, of a more repressive character than that of the knife. When an extremity is involved and the bone is invaded, amputation should be resorted to. The constitutional remedies are limited to anodynes and supporting measures, since internal agents are not of the slightest service in arresting the progress of the affection.

SECT. IX.—INSECTS IN THE SKIN AND CONNECTIVE TISSUE.

The skin and connective tissue are liable to be infested by certain insects, which, although not poisonous, may induce serious suffering, especially in persons of a nervous, irritable temperament. I refer more particularly to the chigoe and the Guinea worm.

The *chigoe*, which is very common both in this country, South America, and the West Indies, is a little insect, scarcely half the size of the smallest pin-head, which penetrates

the skin of the hands and feet, as well as of other exposed parts of the body, for the purpose of sustenance and hatching. It is a species of flea, with a rostrum as long as the body, of a pale-brownish, semitransparent appearance, with legs of a light lead color, which often deposits its eggs in immense numbers. The first effect is an itching sensation, which is soon followed by heat, redness, and swelling, and, ultimately, by an ugly, irritable, spreading ulcer. If the part, when it has attained this stage, be carefully examined, it will be found to contain a cyst, about the size of a pea, and of a bluish color, in which the ova live and multiply with astonishing rapidity. When a number of chigoes penetrate the skin together, the suffering produced by them may be so great as to cause violent constitutional disturbance, and even death.

The treatment consists in picking out the insect and its eggs with a fine needle, care being taken not to rupture the cyst, otherwise the young brood may produce further mischief. Clearance having been effected, the part is well washed with salt water, tobacco juice, or spirit of turpentine, and thoroughly painted with dilute tincture of iodine. The female slaves in the West Indies are said to extract these insects with great dexterity.

The Guinea worm, or little dragon, technically called *filaria medinensis*, also buries itself in the body. It is chiefly met with in tropical countries, particularly in Egypt, Arabia, Persia, Abyssinia, and Guinea, the inhabitants of which are often sorely afflicted by it. Of a white color, and of a filiform shape, it has an orbicular mouth, and a slightly pointed tail, its usual length being from five to twenty inches, and its thickness that of a small violin string. Its ordinary abode is the subcutaneous connective tissue of the feet and legs, although it is also found in other parts of the body, as the scalp, face, neck, scrotum, hands, and arms. It is commonly coiled up circularly, and is inclosed by a distinct cyst, which thus separates it from the surrounding parts. The animal enters the skin when quite young, and gradually increases in size, exciting intolerable itching, inflammation, swelling, and suppuration, often attended with fever, and sometimes followed by gangrene. The precise situation of the worm is generally indicated by a kind of boil, or a hard, ridge-like elevation. When ulceration sets in, the head of the creature usually protrudes at the opening, thus confirming the diagnosis of the case.

In the treatment of this affection, the proper plan is to cut down at once upon the part and extract the intruder. It is worse than useless to waste time in the application of leeches, liniments, and embrocations, which, so long as the cause of irritation lies buried under the skin, can produce none but the most transient effect. If the tumor is already open, and the head of the animal is protruding, extrusion may be promoted by gentle traction.

SECT. X.——AFFECTIONS OF THE HAIRS.

The principal affections of the hairs, surgically considered, are hypertrophy and atrophy.

Hypertrophy presents itself in several varieties of forms, as well as of situation, as in excessive length of the hair on the scalp, beard, or pubes, in extraordinary numbers, or in places which are naturally destitute of it. A redundant development of hair now and then occurs on the forehead, face, or neck. A male child, four months old, was brought to the College Clinic, in 1866, the greater portion of whose forehead, on the left side, was thickly covered with long hair, of the same color precisely as that of the scalp. The corresponding eyebrow was very heavy, and the countenance exhibited altogether a very singular appearance. In the female, hypertrophy of the hair occasionally exists in the form of a strong beard, nearly, if not quite, equal to that of the male. The affection is most common in barren women, of masculine figure and erotic temperament. An accidental development of hair is not unusual. Moles, certain nævi, and congenitally hypertrophied skin, are often covered with hair.

A redundant growth of hair becomes an object of treatment only when it occupies a part of the body that is naturally exposed to observation, as the forehead, face, or neck. The principal remedies are excision and evulsion. The former is more particularly applicable when the affected surface is of very limited extent, as in the case of a congenital mole, or an inconsiderable hypertrophy of the integument. Evulsion is effected with the tweezers, one hair after another being pulled out by the root. The operation, however, is not only painful, but seldom successful, inasmuch as the formative organ still remains, and there is, consequently, a constant reproduction of the hair. The same is true of the use of depilatories, formerly so much in vogue in the treatment of this affection. Most of these preparations are powerful caustics, their active ingredients consisting of quicklime and arsenic, in the form of orpiment, and hence, if great care be not observed in their

management, their destructive influence may extend much more widely than is desirable. Besides, if employed superficially, the hair bulbs will necessarily remain intact, and thus in a short time the new growth will be likely to be as vigorous as the original.

In the case of the child above alluded to, where the redundant hair occupied a large portion of the forehead, I dissected away the entire mass by carrying my knife through the substance of the skin, sufficiently deep to include the hair bulbs, and had the satisfaction to effect a complete cure. Very little bleeding attended the operation, and no unpleasant effects followed. The resulting scar was very trifling.

Atrophy of the hair and depilitation are natural consequences of advancing age, and of certain diseases, as typhoid fever, scarlatina, porrigo, psoriasis, and secondary syphilis. The falling of the hair is often temporary, and then probably depends upon some transient affection of the piliferous follicles. Baldness of the scalp generally begins at the crown of the head, whence it slowly extends in different directions, the hair bulbs gradually wasting and disappearing. I have seen five cases of secondary syphilis in which, in the course of a few months, every hair of the body dropped off, and was never reproduced. The baldness is sometimes congenital, as in the case of a child, four years of age, a patient of mine, whose entire body was destitute of hair.

The treatment of depilitation must be conducted with special reference to the nature of the exciting cause; for so long as this continues in operation little progress can be made towards a permanent cure. The general health, if at fault, must be amended, and the suffering surface excited with stimulating lotions, as solutions of zinc, copper, tannic acid, iodine, and nitrate of silver. The use of iodide of potassium in union with bichloride of mercury is indicated when there is a syphilitic taint of the system. In gradually gravescent baldness of the head, great benefit often accrues from cutting the short, stunted, and broken hair once a month close to the scalp. The operation imparts a new impulse to the piliferous follicles, and is frequently followed by great and permanent improvement.

CHAPTER II.

DISEASES AND INJURIES OF THE MUSCLES, TENDONS, BURSES, AND APONEUROSES.

SECT. I.——MUSCLES.

THE muscles are liable to wounds and lacerations, inflammation, atrophy, hypertrophy, and different kinds of transformations, especially the fatty, which occasionally exists in a very high degree, and over a considerable extent of the body. They are also subject to some of the morbid growths, and to the development of hydatids and serous cysts.

1. *Wounds.*——When a muscle is divided by a sharp instrument, or accidentally ruptured, its fibres immediately retract so as to drag the edges of the wound more or less widely asunder. The extent to which this separation may be carried varies, in general, according to the length and thickness of the muscle, from a few lines to as many inches. In transverse fractures of the patella, the action of the straight muscle of the thigh often draws the superior fragment from three and a half to four inches away from the inferior; and it is reasonable to conclude that fully as extensive a gap would be produced between the ends of this muscle if it were cut in two, or torn asunder. In rupture of the straight muscle of the abdomen, the edges of the subcutaneous wound have repeatedly been found to be separated from an inch and a half to two inches. In the operation for the cure of strabismus, the retraction of the posterior extremity of the divided muscle is seldom less than from four to six lines, and often even considerably more.

The above facts are highly interesting in a practical point of view, inasmuch as they point out the propriety of adopting prompt and energetic measures for effecting and maintaining apposition of the ends of the divided muscle; for observation has shown that the more accurate this is the more speedy and perfect will be the cure. If the edges are brought fully and intimately together, the union will necessarily require but a small quantity of plastic matter for its early and complete consolidation. If, on the other hand,

the gap amounts to several inches, either no union will occur, or it will be effected through the intervention of a large quantity of fibrous tissue, possessing none of the properties of muscular fibre. Hence the affected structures must always remain proportionately weak and disabled. But this is not the only inconvenience that follows such an accident; in wounds of the abdominal muscles, for example, the gap is sure to give rise to hernia, and it is easy to see that a deficiency of this kind elsewhere would hardly be productive of less serious effects. The only rational remedy under such circumstances, is the thorough union of the divided ends of the muscles by sutures, metallic ones being the best.

2. *Laceration.*—Rupture of the muscles is often produced by very trifling causes, the most common of which are leaping, or jumping across ditches or over fences, lifting heavy weights, or falls from a considerable height, in which the person makes a powerful effort to ward off injury. Cases are upon record of women having lacerated the abdominal muscles during parturition. Injuries of this kind are most likely to happen, other things being equal, when a muscle has undergone the fatty degeneration, which, by rendering its fibres soft and lacerable, acts as a powerful predisposing cause of rupture. Long-continued inactivity of a muscle, followed by sudden and violent contraction, may be mentioned as another predisposing cause of the accident.

The muscles which are most liable to rupture are the straight muscles of the abdomen, the psoas, deltoid, the two-headed flexor of the arm, the straight femoral, and the gastrocnemius.

The place where the rupture usually occurs is near the junction of the fleshy fibres with their tendons; but occasionally a muscle may give way at its middle, or, in fact, at almost any portion of its extent. In twenty-one cases of this affection analyzed by Sédillot, the rupture, in thirteen, took place at the insertion of the fleshy fibres into their tendons, while in the remainder it was seated in the body of the muscle itself. The laceration is sometimes limited to a few fibres; at other times it involves the entire thickness of a muscle, or of a muscle and its aponeurotic envelop. Finally, cases occur in which a number of muscles are ruptured.

The symptoms are not always well marked, especially when the affected muscle is deep-seated. In general, it may be assumed that such an accident has occurred, if, at the moment of some violent bodily exertion, as in leaping a ditch or fence, the individual hears a distinct noise or snap, like the crack of a whip, feels severe pain in some particular spot, and either falls, or has but an imperfect use of himself. Upon examining the suffering part, a vacuity will probably be noticed at one point, and an unusual prominence at another, followed by more or less discoloration and tenderness under manipulation. Occasionally the accident is attended with considerable hemorrhage, from the rupture of some of the smaller vessels. The pain is often very sharp, and rarely entirely disappears until after the primary effects of the lesion have measurably passed off.

Temporary lameness and inability to move about for some time are, generally, the only serious consequences to be apprehended from this accident, provided it is properly managed immediately after its occurrence. In most cases, a considerable period must necessarily elapse before the reunion of the torn structures will be sufficiently firm to justify their accustomed use. Occasionally violent symptoms supervene; and an instance has been reported to me of a young man who lost his life from rupture of the psoas muscle, death having been preceded by severe inflammation and infiltration of pus.

The treatment of this lesion cannot be the same in all cases, or under all circumstances. Whenever it is practicable, from the superficial situation of the affected muscle, its ends, whether cut or ruptured, should be freely exposed, and then carefully approximated by a sufficient number of stitches to hold them in contact until firm union has been established. For this purpose the threads should be carried nearly through the entire thickness of the muscle, the object being thorough apposition both of the superficial and deep portions of the wound. In case the muscle has been ruptured, the edges of the wound may be so ragged as to require some retrenching before placing them in contact, precisely as in a lacerated wound of the integument. If the precaution of stitching the parts be neglected, the results above adverted to will be inevitable, and it is, therefore, impossible to insist too strongly upon the importance of attention to this rule, which is so much neglected by surgeons.

The parts, being properly approximated, are next placed in an easy, elevated, and relaxed position, splints and bandages being employed for this purpose, if necessary, and they are then treated upon general antiphlogistic principles. If the ruptured muscle is deep-seated, our chief reliance must be upon rest and relaxation, conjoined with soothing

and astringent applications, along with suitable internal remedies, to moderate the resulting inflammation. In laceration of the muscles of the extremities, important advantage may always be obtained from the use of two rollers, applied in opposite directions, as the ends of the wound may thus not only be more effectually approximated, but the contraction of the fleshy fibres more easily controlled, than in any other manner.

3. *Inflammation.*—Inflammation of the muscles, or myositis, occurs in two varieties of form, the acute and chronic; both, however, are uncommon, and are chiefly observed as consequences of external injury, as blows, wounds, or contusions, such as are met with in fractures and dislocations; or as effects of gout and rheumatism. The sheaths of the muscles very frequently, if not generally, participate in the morbid action. When the inflammation is at all severe, considerable effusion of serum and lymph may take place, but it is seldom that the disease runs into suppuration, much less mortification. The latter termination is chiefly met with in erysipelas and carbuncle, in old, worn-out subjects, and in persons of different habits and conditions after violent external injury. It is easily recognized by the dark, greenish color of the fleshy fibres, by their softness and lacerability, and by their excessively fetid odor. The parts are detached in ragged shreds, and bathed in a thin, sanious dirty, and offensive fluid.

Acute inflammation of the muscles is characterized by excessive pain, of a sharp, darting character, or by dull, heavy, aching sensations, accompanied with a feeling of soreness, and aggravated by the slightest motion and pressure. In some cases, as when the disease supervenes upon fractures or the amputation of a limb, it is attended by a remarkable twitching or jerking, occasionally amounting to actual spasm, which only yields to large doses of anodynes, and hot, soothing applications.

Chronic myositis is not uncommon; like the acute variety, to which it generally succeeds, it is more frequently met with, surgically considered, as a secondary than as a primary affection. When long continued, it is very prone to give rise to fatty degeneration, softening, ulceration, and other changes, which it is often impossible to cure.

4. *Fatty Transformation.*—Fatty degeneration of the muscles is often, if not generally, a result of chronic inflammation, especially when conjoined for any considerable period with steady, persistent inactivity, or want of exercise. Whether inflammation, however, is always necessary to its production is still a mooted question, although it is highly probable that it is. When thus affected, the fleshy fibres assume a pale yellowish, whitish, or slightly reddish color, at the same time that they are unctuous to the touch, and so much softened as to yield under the most trivial force. On pressure, a clear, oily fluid exudes, which greases the finger, is highly inflammable, and is composed of elain, adipocire, and ordinary fat, in variable proportions. These substances are not deposited, as some have conjectured, between the fleshy fibres, but form actually a portion of their constituent principles, their proper tissue being found, when examined microscopically, to be filled with granules, partly interposed between their striæ, and partly replacing them.

The fatty transformation is most common, as well as most marked, in the muscles of the loins, hip, thigh, and leg of old persons affected with paralysis. It is likewise occasionally observed in the heart, and now and then in the muscles around unreduced luxations, large exostoses, and old, deep-seated ulcers. When the change is profound and extensive, it sometimes involves the corresponding tendons and aponeuroses, which, in consequence, lose their polished, satin-like lustre. The disease does not admit of cure.

5. *Ulceration.*—Ulceration of the muscles is an uncommon occurrence. It is chiefly noticed in phagedenic sores of the leg, extending successively through the integument, connective tissue, aponeuroses, and, finally, the muscles, which, however, generally resist its encroachments in a very remarkable degree. In some of these cases the fleshy fibres are in a complete state of fatty degeneration, of a whitish color, and so soft as to admit of being scraped away with the greatest facility. When the ulceration is slight, the restorative process usually proceeds kindly, and the breach is soon filled with healthy granulations. No special treatment is required in this disease, apart from the remedies ordinarily employed under such circumstances.

6. *Contraction.*—Another effect of inflammation of the muscles, or of the muscles and their fibrous envelops, is contraction of their fleshy fibres, leading to marked disorder of their functions, along, perhaps, with severe pain, and even great deformity, as is so often seen in wryneck, consequent upon inflammation of the sterno-cleido-mastoid and splenius muscles, and in the muscles of the thigh from the effects of hip-joint disease. In many of these cases the disease is obviously of a gouty or rheumatic character, and it then often occurs at a very early age, the immediate exciting cause being usually exposure to cold, or cold and wet.

In the treatment of myositis attended with contraction of the affected muscles, the first object should be to ascertain, if possible, the nature of the exciting cause, as to whether it is the result of rheumatism, gout, scrofula, or syphilis, or of external injury, as a sprain, twist, blow, wound, or contusion; for upon the knowledge thus derived must necessarily depend the character of our remedies, and the chance or otherwise of a cure. I have usually received marked benefit in these cases from the use of the wine of colchicum in combination with a full dose of morphia at bedtime; aided by active purgatives and diaphoretics, especially the warm bath, a well-regulated diet, and the frequent application of Granville's lotion in union with laudanum and soap liniment, thoroughly rubbed upon the affected parts. The muscular rigidity attendant upon a syphilitic state of the system is best treated with iodide of potassium, either alone, or conjoined with mercury.

In the more subacute or chronic cases of muscular contraction, great benefit may be expected from the use of the hot and cold douches, employed twice a day, and followed first by dry friction, then by the application of stimulating liniments, and finally by thorough shampooing. Frequent motion is also generally of great service, to break up adhesions, and to promote the absorption of effused fluids, upon which the affection so often mainly depends, as is observed in the shortened and rigid state of the limbs after severe fractures and dislocations.

7. *Atrophy.*—Atrophy of the muscles, of varying degrees, is occasionally observed; it may occur in any of the voluntary muscles, but is most common in those of the shoulder and hip, the deltoid suffering perhaps more frequently than any other. It may depend upon different causes, but generally it is produced by inflammation, palsy, or defective circulation; indeed, whatever has a tendency to impair the function of innervation, retard or diminish the supply of blood, or induce permanent inactivity in a muscle, may be considered as a cause of the affection. Hence it is found that the lesion is usually associated with paralysis, whether proceeding indirectly from disease of the cerebro-spinal axis, or directly from injury of the nerves distributed to the suffering structures. The muscles around luxated joints, especially those of the hip and shoulder, are frequently atrophied, either simply from want of use, or, what is more probable, the conjoint influence of inflammation and inactivity. In coxalgia, similar effects generally occur, the wasting usually involving all the muscles of the lower extremity. The fact that gout and rheumatism are frequently productive of atrophy of the muscles is familiar to every practitioner.

The extent to which the wasting of the muscles may proceed is variable. When it exists in a high degree, they may be reduced to mere membranous bands, pale, flaccid, and almost devoid of irritability; in some rare instances their fleshy fibres are completely absorbed, a dense fibrous substance being all that is left in their place; or, instead of this, they are found to be softened and transformed into fatty matter.

In the treatment of atrophy of the muscles, the first object should be to ascertain, if possible, the nature of the exciting cause, by removing which the lesion sometimes rapidly disappears of its own accord, or, at all events, under very simple management. Atrophy dependent upon imperfect supply of blood is often irremediable, and the same is frequently the case when it is caused by gout or rheumatism, or when it is conjoined with the fatty degeneration. The treatment of atrophy dependent upon loss of innervation, constituting what is called wasting palsy, will receive special attention in the chapter on the diseases and injuries of the nerves, where its consideration properly belongs.

Whatever the cause of atrophy of the muscles may be, much may be done, after that has been removed, towards effecting restoration, by the steady and persistent use of the hot and cold douches, stimulating embrocations, dry frictions, and regular, systematic exercise of the affected structures, educating them, so to speak, and thus gradually qualifying them, for the resumption of their appropriate functions.

8. *Tumors.*—Various morbid growths occur primarily in and among the muscles, the principal of which are the hydatid, cystic, fibrous, muscular, and erectile.

a. It is uncommon to meet with *hydatids* in the muscles, and I have myself seen only one case. The patient, a laboring man, twenty-five years of age, had accidentally discovered a swelling in the substance of the right deltoid muscle six months previously, when it was hardly as large as a hazelnut. At the time of my examination, it was of the volume of an almond with its shell, of a rounded, elongated shape, a little movable, and of a firm, fibrous consistence, with a slight degree of elasticity. Within the last few weeks the tumor had become somewhat painful, especially after exercise, and the pressure made in examining it was productive of considerable uneasiness. The skin over it was perfectly healthy.

The diagnosis of the tumor could not, of course, be determined before hand; what it

resembles most, especially in point of consistence, was an enlarged lymphatic gland, but the rarity of such a disease in this situation invalidated this conclusion, and left me in complete doubt as to the true nature of the case. It was too deep-seated for a sebaceous tumor, and it possessed none of the external characters of a fatty, fibrous, or sarcomatous one.

During the excision the knife penetrated the tumor, letting out a small quantity of thin pus; a circumstance which seemed, at the moment, to confirm the idea that the affection, after all, was simply a diseased lymphatic gland. On continuing the dissection, however, I soon found that there was a distinct cyst, which, being collapsed, was sepa-rated with some difficulty from the fibres of the deltoid muscle, in which it was Fig. 258. imbedded. The operation being completed, a small body, fig. 258, was picked up, which, on inspection, proved to be a globular hydatid, not more than six lines in diameter, and furnished with a distinct sucker. The cyst was very soft and thin, smooth internally, and externally filamentous.

Hydatid.

β. Tumors of a *cystic* character are occasionally met with in and among the muscles. In a case of this kind, which I saw with Professor Da Costa, the growth, occupying the upper and outer portion of the thigh, was nearly of the volume of an adult head. The patient, a female, fifty-eight years of age, in a fall down a flight of stairs, struck the limb severely, causing deep ecchymosis and great difficulty in walking. At the end of two months a swelling formed, which, gradually increasing, in less than a year, acquired the size above mentioned, being at the same time the seat of severe dart-ing pain, with considerable discoloration of the integument. The tumor fluctuated indis-tinctly, and a puncture with the exploring needle gave vent merely to a few drops of oily fluid. When removed by Dr. Brinton, it was found to be composed of a very thick, dense, fibrous cyst, filled with a sero-oleaginous liquid. The patient gradually recovered from the effects of the operation, but was troubled for a long time afterwards with pain in the limb and difficulty in walking.

The voluntary muscles are sometimes occupied by cysts containing blood, owing to the laceration of their fibres and vessels, the latter of which thus part with their contents. The effused fluid, coagulating, is gradually organized and eventually encapsulated, the covering being occasionally very thick, dense, and strong. In rare cases the blood is poured out spontaneously, or under the influence of very slight injury, as a blow or con-tusion. If the blood be partially devitalized at the moment of the accident, it will be likely to retain its fluidity, and to become ultimately, in great degree, if not entirely, de-colorized, so as to resemble an accumulation of serum, and act as a foreign body.

γ. Tumors of a *fibrous* and *myomatous* structure have been found in different volun-tary muscles, especially in those of the chest, shoulder, arm, and thigh; they are gene-rally of small size, slow in growth, and of firm consistence, with a tendency, now and then, to recurrence after excision.

δ. *Osseous* tumors are uncommon in the voluntary muscles. Mr. W. F. Teevan, in a monograph on morbid growths in this situation, has been able to find only three cases of the kind.

ε. Tumors of an *erectile* character have been seen in the sterno-mastoid, deltoid, semi-membranous, external oblique, long supinator, and semitendinous muscles. At the Col-lege Clinic, in 1870, I removed from the deltoid muscle of a girl, fifteen years of age, a cavernous tumor, which presented all the external features of a cyst.

SECT. II.—TENDONS.

The tendons, like the muscles, are liable to wounds and lacerations, but, unlike them, they very rarely, if ever, suffer from morbid growths. Inflammation of these structures is also very infrequent.

1. *Wounds.*—Tendons, when divided subcutaneously, readily unite through the inter-vention of plastic matter, without the occurrence of any considerable degree of inflam-mation. Indeed, the idea is very common at the present day that such wounds are al-ways repaired without inflammation, it being alleged that this process, instead of being necessary for this purpose, is a positive detriment. Such a doctrine, however, is unten-able. If its advocates mean that the inflammation is very slight, or not characterized by the ordinary phenomena, I perfectly agree with them; but if they wish to be understood as affirming that inflammation is entirely absent throughout, it is certainly not true.

When a tendon, such, for example, as that of the heel, is cut across subcutaneously, the first thing that is noticed is the retraction of the divided ends, so as to leave a distinct

gap between them, often ranging from an inch and a half to two inches, according to the size of the cord and its previous tension, or the degree of force employed in stretching the parts with which it is connected. Inflammation, generally of a very slight form, next takes place, and, soon after this is established, plastic matter is poured out, filling up the space between the two extremities of the tendon, and at the same time connecting them together. As the abnormal action subsides, fusiform cells form in the interior of the effused matter, and, the process of organization thus begun steadily advancing, the new substance is gradually converted into fibrous tissue, and this, in turn, at length into tendinous, which, however, although well adapted to fulfil the purpose for which it is intended, is, like all new tissues, a very imperfect type of the original. The reproductive process generally progresses very rapidly, so much so that the person soon acquires an excellent use of the affected parts. It is upon a knowledge of this property in tendon, when subcutaneously divided, to speedy reunion, that is founded the operation of tenotomy, one of the great improvements in modern surgery.

When a tendon is divided in an open wound, there is rarely, if ever, any spontaneous reunion, for the reason, first, that the ends retract too far to admit of thorough adjustment, and, secondly, that the wound nearly always suppurates; an occurrence highly inimical to adhesive action. All the earlier operations of tenotomy that were performed according to this principle failed, in consequence of the violence of the resulting inflammation.

The treatment of a divided tendon, then, with an open wound, is very different from that where the wound is subcutaneous. In the latter, the application of a bit of adhesive plaster to the puncture, to exclude the air, and a little attention to rest and position, make up the sum total of the surgeon's duty. In the former, on the contrary, the cut ends must be carefully approximated by the silver wire suture, the remainder of the wound being firmly closed; or the limb with which the tendon is connected must be placed in the most thoroughly relaxed position possible, in order to approximate its extremities, and thus afford them an opportunity of reuniting, an occurrence, however, which will certainly seldom take place under any circumstances, however propitious. The experiments of Dr. Levert, of Mobile, performed many years ago, prove that union between the divided ends of a tendon will be much more likely to proceed kindly and satisfactorily when the parts are held in contact by a metallic suture than by an ordinary one. Surgeons do not seem to have taken sufficient advantage of the results of these researches, and it is fortunate that the introduction of the wire suture by Dr. Sims has tended to recall attention to them.

Cases occasionally arise in which a tendon remains ununited, with a large intervening gap, long, perhaps, after the external wound has healed. In such an event it has been proposed to puncture the retracted extremities in different directions with a delicate tenotome, on the same principle that we sometimes perforate the ends of an ununited fracture. The procedure, however, seldom, if ever, succeeds, even in the most favorable circumstances. A much better plan is to expose the parts by a free incision, and, having pared the retracted extremities of the tendon, to unite them with silver wire, care being taken to keep the resulting inflammation within the limits of moderate fibrinous exudation. Since I first recommended this method, many years ago, successful cases of it have been reported, among others, by Dr. Warren Webster, of Illinois, Delore, of Lyons, and Dr. Simmons, of Sacramento.

2. *Rupture.*—Tendons are sometimes torn away from their sheaths along with the fleshy fibres into which they are inserted, hanging, perhaps, merely by one extremity: when this is the case, it would be useless to replace them, even if this were practicable, as there would be no likelihood whatever of reunion; on the contrary, severe inflammation and sloughing would be inevitable.

When a tendon is ruptured subcutaneously, a loud snap, like the crack of a whip, is generally heard at the moment of the accident, especially if the cord is a large one; the part is instantly deprived of its functions, and a well-marked gap, interval, or hollow is perceptible at the site of the injury. More or less inflammation follows, and a long time usually elapses before the patient regains the use of the affected limb. The tendon which is most liable to suffer in this way is that of the heel, its rupture being generally caused by violent muscular exertion, either for some special effect, as in the case of persons on the stage, or for the purpose of saving the body from a fall, as when the individual makes a false step. John Hunter ruptured his tendo Achillis in dancing.

The treatment of a subcutaneously ruptured tendon must be conducted by rest and complete relaxation of the affected structures, so as to enable us to bring the divided ends as closely together as possible. To effect this to the best advantage, special apparatus is

generally required, as well as the greatest attention and vigilance on the part of the practitioner. The time necessary for obtaining satisfactory union varies, on an average, from six to eight weeks.

3. *Dislocations.*—The tendons are sometimes dislocated, or thrown out of the canals in which they are naturally situated, in consequence of the laceration of the connecting ligaments, or retaining bands. The accident, which is most apt to befall the tendon of the two-headed flexor of the arm, as it runs along the bicipital groove of the humerus, is generally attended with severe pain at the site of injury, inability to move the affected limb, and more or less discoloration of the integument. Considerable swelling often follows, and, if the accident is overlooked, permanent lameness may result. Replacement should be effected as speedily as possible, a procedure which is usually very easy, provided the true nature of the case is recognized soon after its occurrence.

4. *Hypertrophy.*—Finally, the tendons are occasionally the subjects of hypertrophy, exhibiting an irregular, knotty appearance, which is not only unseemly, but sadly productive of discomfort. The affection is most common in gouty, rheumatic, and syphilitic persons, and is usually very readily detected both by touch and sight. The proper remedies are removal of the exciting cause, the exhibition of iodide of potassium, either alone or in union with mercury, and sorbefacient applications with massage.

5. *Thecitis.*—Inflammation of the sheaths of the tendons, technically called thecitis, may originate as an independent affection, or, as not unfrequently happens, it may begin consentaneously with inflammation of the parts which it surrounds and lubricates. In either event, the disease is often of a much more serious character than is generally imagined, nothing short, perhaps, of permanent lameness and deformity being the result. Various causes may give rise to thecitis; thus it is occasionally induced by gout, rheumatism, syphilis, and exposure to cold. On the other hand, it often supervenes upon external injury, as a sprain, blow, puncture, or contusion. In the hand and fingers it is frequently met with as a consequence of sprains of the wrist-joint, or fracture of the lower extremity of the radius and ulna. In regard to its character, it may be acute or chronic; more generally, perhaps, the latter than the former. Once fairly established, it is commonly removed with much difficulty, and is liable, as just stated, to be followed by the most disastrous effects.

The most common sites of thecitis are the sheaths of the tendons of the fingers, the wrist, elbow, feet, ankles, and knees; the disease may occur by itself, or in union with inflammation of burses and the lining membrane of the neighboring joints. In thecitis of the hands and fingers it is seldom that the disease exists except in this association, especially when it has been caused by a sprain, dislocation, or fracture of the radio-carpal articulation. In this condition, as I have had frequent occasion to notice, the inflammation is extremely liable to extend to the sheaths of all the tendons, as well as the joints of the fingers, rendering them stiff, tumid, and exquisitely painful. If the case is neglected or improperly treated, the whole hand becomes rigid; and the fingers, wasted and attenuated, present more the appearance of the claws of some of the inferior animals than the natural structures. The pain accompanying this form of thecitis often reaches as high up as the axilla, and I have known it to be so distressing at night as to deprive the patient completely of sleep for days together.

Thecitis, although apparently a trivial disease, assumes a most important character when it invades a number of thecæ simultaneously, or successively, and the gravity of the case is greatly augmented if there is at the same time considerable involvement of the neighboring joints, as when the attack takes place in the hands and fingers. Hence no time should be lost, and no pains spared, to get rid of the inflammation before it has produced any serious structural changes, particularly firm and extensive adhesions of the thecæ to their tendons. Leeches and tincture of iodine, either alone or in union with saturnine and anodyne fomentations, are the chief topical remedies upon which reliance is to be placed, while the patient is freely purged and restricted in his diet. Venesection and antimony will be necessary if the case prove obstinate. When the disease is associated with a gouty or rheumatic state of the system, wine of colchicum will be of service. In thecitis dependent upon a syphilitic taint, recourse must be had to iodide of potassium.

If the parts have become stiff in consequence of firm adhesions, the hot and cold douches, followed in immediate succession, along with frictions with sorbefacient liniments, embrocations, or unguents, steady, systematic passive motion twice a day, and the application of the bandage to support the affected structures, will gradually, although in general not under several months, effect restoration. In obstinate cases a mild mercurial course may become necessary, on the same principle that such a plan is occasionally adopted in

inflammation of other tissues attended with plastic effusions and morbid adhesions. When the disease is located in the hand, I have generally found it expedient to bandage each finger separately, and to support the parts upon a carved splint. In short, in many of these cases nothing but the most zealous and determined perseverance will enable us to effect a cure.

6. *Painful Crepitation.*—There is a singular affection of the tendons originally described by some of the French surgeons, as Boyer, Velpeau, Michou, and others, under the phrase of " painful crepitation." It is most generally met with in the tendons of the muscles of the forearm and hand, particularly the radial extensors at the outer and back part of the wrist, but is also liable to occur in those of the leg and toes. Now and then it is observed in the long head of the biceps. The disease evidently consists in inflammation of the sheaths of the affected tendons, followed by a deposit of plastic matter, roughening the contiguous surfaces, and thus occasioning the peculiar pain and crepitating sensation by which it is distinguished. The most common exciting causes are sprains, gout, rheumatism, and overexertion of the muscles. The affection is often attended by a certain degree of swelling of the limb at the seat of the morbid action, but there is rarely any decided dis- coloration of the surface, or, if there is, it readily disappears under pressure. More or less impairment of function is present. The characteristic symptom is a crepitation, which closely resembles the noise produced by rubbing coarse starch between the fingers, or the sound occasioned by treading on dry snow in very cold weather. In the forearm it may always be readily elicited by alternately pronating and supinating the limb. Great care is often necessary not to confound this species of crepitation with that of fracture. Its roughness and the mode of producing it will generally be sufficiently diagnostic of its nature.

The affection often disappears spontaneously, or under very simple measures, of which the most important are rest, sorbefacient lotions and liniments, and the hot and cold douches.

7. *Ganglion.*—A ganglion, as seen in fig. 259, from a clinical case, is a small circumscribed cyst, situated along the course of a tendon, to which it is intimately united. Composed of a single layer, which rarely exceeds the thickness of the dura mater, it is filled with a thin, yellowish fluid, more or less ropy in its character, and bearing a very strong resemblance, in its general features, to olive oil, the white of an egg, or a solution of gum arabic. In

Fig. 259.

Ganglion of the Extensor Tendons of the Hand.

cases of long standing, the contents of the sac are sometimes nearly entirely solid, consist- ing of a thick, ropy substance, of a dark color, not unlike currant jelly ; of masses, appa- rently, of semiorganized lymph ; or of small bodies similar, in shape and size, to cucumber seeds. In a ganglion of the hand upon which I operated some years ago, I observed the singular-looking bodies sketched in fig. 260. They appeared to be in different stages of development, and were evidently merely so many enlarged fringe-like processes of the synovial membrane, which had undergone fibroid transformation, and become detached in consequence of the continual friction of the tendon to which the sac was connected.

The volume of the cyst varies from a pea to that of a hickory nut ; it is of a globular or ovoidal shape, somewhat elastic, perfectly movable, free from pain, and unaccompanied by any discoloration of the skin. A sense of stiffness and of uneasiness, felt chiefly along the course of the tendon on which it is situated, sometimes attends its formation, and induces the patient to apply for advice. I have never known a ganglion to suppurate.

The tumor is most common in women, and is met with chiefly along the extensor tendons on the back of the hand, wrist, and lower extremity of the forearm. I have

seen several cases in which such a swelling was situated over the radial artery, the pulsations of which were so thoroughly imparted to it as to induce the belief, at first, that it was an aneurism of that vessel. A cyst of this kind in the palm of the hand is a rare occurrence. On one occasion I operated upon a young woman who had two ganglionic cysts, each of the size of a small bird's egg, upon the dorsal surface of the foot. The sole of the foot sometimes suffers in a similar manner. The affection now and then appears at an early age. I have met with it in a child only eight years old. The great majority of cases, however, occur in young adults.

Fig. 260.

Fibroid Bodies of Ganglion.

How this cyst is formed is still a mooted question. The probability, however, is that it is merely a sacculated expansion of the sheath of the tendons, and not, as some pathologists suppose it to be, a new formation. From the fact that it is most common in hard-working people, it, doubtless, owes its origin to inflammation, although it is seldom directly chargeable to external violence.

The most simple and trustworthy method of treatment consists in rupturing the ganglion, and scattering its contents into the surrounding connective tissue, where they are speedily absorbed. The operation may usually be performed with the two thumbs, but, if the cyst is old and very firm, it will be necessary to strike it with a book, as was done by the older surgeons, or to pierce it previously with a bistoury or tenotome. Evacuation having been effected, a compress inclosing a piece of coin or sheet lead is applied to the part, to promote the adhesion and obliteration of its cavity, the limb being maintained at rest until the resulting inflammation has subsided. When the ganglion is quite young, relief may occasionally be afforded by the application of iodine and systematic compression; ordinarily, however, such means are quite futile. Iodine is sometimes advantageously employed as an injection, in the same manner as in hydrocele. When the ordinary means fail, my practice is to cut up the sac as minutely as possible with a delicate bistoury, inserted subcutaneously, steady compression being afterwards maintained until obliterative inflammation has taken place. Both excision and direct incision must be avoided, as they are liable to cause erysipelas and to endanger the functions of the part.

What is called by authors the diffused or *compound ganglion* is merely a sacculated condition of one or more of the sheaths of the flexor tendons of the hand and wrist, and of the dorsum, sole, or inner side of the foot. The pouch thus formed is sometimes several inches in length, especially in the palm of the hand, by an inch or more in width, soft, fluctuating, irregular in shape, and, at first, free from pain, but liable, when inflamed, to more or less suffering and consequent lameness of the limb. In the older cases the sac often contains little bodies like melon seeds, and, under such circumstances, pressure always elicits a distinct crepitating sensation, characteristic of the nature of the affection. In the earlier stages of the disease the fluid is generally clear and thin, but as the morbid action advances, it becomes dark, turbid, bloody, and more or less thick, owing to the change of structure in the synovial sheath, which is often much thickened and studded with reddish and imperfectly organized granulations. The affection usually comes on without any assignable cause, and is much more frequent in women than in men, in whom it often occurs at an early age.

Rest, blistering, and iodinization afford temporary relief in this form of ganglion, but beyond this they do no good. The radical cure is based upon the use of the seton, consisting of two or three strands of well-oiled threads, introduced with a curved needle or eyed probe, and retained until a sufficient amount of inflammation has been excited to produce obliteration of the pouch. The limb meanwhile must be kept at rest, and every precaution taken to restrict the inflammation within proper limits. Excision is fraught with great danger.

SECT. III.—SYNOVIAL BURSES.

The synovial burses, bursæ mucosæ, or mucous pouches, exist in considerable numbers in various regions of the body, especially about the joints of the extremities, being small, semitransparent sacs, occupied by a thin, unctuous fluid. They are for the most part interposed between bone and tendon, tendon and tendon, bone and skin, or tendon and skin, their object being to facilitate motion and ward off pressure. Hence, they are

always most conspicuous in those situations which are habitually subjected to friction; and for the same reason they are occasionally developed to meet special contingencies arising from accidental causes, as the pressure of the shoe, crutch, or artificial limb. In club-foot synovial pouches are constantly formed upon those parts of the foot which, being partially displaced, are compelled to sustain the weight of the body. Altogether there are about one hundred and fifty of these sacs in the natural state.

The largest and most important synovial pouches, surgically considered, are situated on the acromion process of the scapula, the space between the hyoid bone and thyroid carti-lage, the condyles of the humerus and the olecranon process, the styloid projections of the ulna and radius, the tuberosity of the ischium, the great trochanter, the anterior superior spine of the ilium, the front of the patella, the condyles of the femur, the tuberosity of the tibia, the ankle, the calcaneum, and the heads of the first and fifth metatarsal bones.

The principal affections of the burses are inflammation, suppuration, induration and thickening, dropsical accumulations, the development of fibro-cartilaginous concretions in their interior, and contusions. It is not improbable that they may occasionally be the seat of some of the malignant formations; but as I have never met with any examples, it may be assumed that they are very uncommon.

Inflammation of these sacs may occur either in an acute or a chronic form, the latter being, however, by far the more frequent. The usual cause is inordinate and long-con-tinued friction conjoined with pressure. The disease may also be produced by blows, contusions, wounds, and punctures, and, in persons predisposed to gout, rheumatism, scrofula, and syphilis, by exposure to cold, or the sudden repulsion of the cutaneous per-spiration. The housemaid's knee, and the collier's elbow, are examples of inflamed and enlarged burses developed under the influence of concentrated and protracted pressure; another instance not less striking, is afforded by the bunion which so frequently forms over the inner surface of the metatarso-phalangeal articulation of the big toe. Constitu-tional syphilis, especially in its later forms, is an occasional cause of bursitis, having its origin either in the sac itself, or by extension from the neighboring tissues.

1. *Acute inflammation* of the burses is generally productive of very severe suffering; the pain is tensive, throbbing, persistent, and greatly aggravated by motion, pressure, and dependency; the swelling, which is often considerable, is usually due partly to exterior deposits, partly to an accumulation of synovial fluid, the quantity of which is commonly very much increased; the skin, of a dusky, reddish color, is deeply congested; and the functions of the affected structures are greatly impaired, if not completely arrested. Not unfrequently the swelling, is of an œdematous or erysipelatous character, pitting readily under pressure, and being the seat of a dull, heavy, prickling sensation. In the more severe forms of acute bursitis, there is usually considerable constitutional involve-ment, the patient being feverish, thirsty, restless, and troubled with headache, loss of appetite, and other disagreeable symptoms.

Upon cutting into the affected sac, its inner surface is found to be deeply congested, and roughened with lymph, while its cavity is filled with a bloody, serous, or sero-oleaginous fluid, often in considerable quantity, especially if the disease has been of some standing.

Bursitis occasionally passes into suppuration, the symptoms, when this is about to occur, suddenly assuming a more severe form, precisely as when matter is about to be deposited in any other part of the body. The pus, usually of a thin, oleaginous character, and intermixed with flakes of lymph, may find its way to the surface by ulcerative action, or it may discharge itself into a neighboring joint, although such an event is extremely rare, and is not likely to occur unless the joint has freely particatipated in the inflammation.

The treatment of this disease must be actively antiphlogistic; the part and system are kept perfectly at rest; leeches are applied to the affected surface, followed by anodyne and saturnine fomentations; the bowels, diet, and secretions are duly attended to; and the pain, which is generally severe, is controlled by morphia, or morphia, antimony, and aconite. If matter form, as denoted by an increase of pain and other symptoms, a free and early incision is made, the edges of the opening being kept asunder by a small tent to prevent reaccumulation. The milder forms of bursitis are generally easily combated by rest, cooling laxatives, and the application of tincture of iodine, or, what is frequently preferable, a blister, large enough to extend over the affected surface, and retained suffi-ciently long to produce thorough vesication.

2. *Chronic inflammation* of the burses occasionally gives rise to remarkable structural changes, the most common of which is an indurated and hypertrophied condition, the result either of long-continued interstitial deposits, or of the formation of adventitious membranes. However this may be, the walls of the affected sac are sometimes found to

be upwards of a quarter of an inch in thickness, and of a dense, fibrous consistence, without the slightest trace of its primitive characters. In this condition, the cavity of the pouch is generally very small, filled with altered synovial fluid, and roughened upon its surface, so as to exhibit an appearance not unlike that of a honeycomb. Now and then shreds of lymph are stretched across its interior, dividing it into different compartments. In cases of very long standing, partial ossification of the cyst has been noticed, but such an occurrence is very uncommon.

These chronic enlargements of the burses are often very obstinate and troublesome, resisting not unfrequently the best directed efforts of the surgeon for their removal. The remedies upon which most reliance is to be placed are sorbefacient applications, as iodine and chloride of ammonium, blisters, mercurial inunctions, and systematic compression. When these means fail, and the tumor is productive of pain and other inconvenience, our only resource is thorough excision, care being taken, especially if a large joint is close by, not to cut too widely away from the morbid mass, lest the synovial membrane of the articulation be inadvertently pierced, or so much injured as to excite violent inflammation.

3. Another result of chronic inflammation of these bodies is an accumulation of their natural secretions, giving rise to what is called *dropsy*, or hygroma, of which one of the best examples is afforded in the so-termed housemaid's knee. The fluid, varying in quantity from a few drachms to six or eight ounces, according to the size and situation of the affected burse, and the duration of the disease, is generally of a pale straw color, of a slightly unctuous consistence, and of a notably saline taste ; now and then it is reddish or brownish, and remarkably thick and viscid. It is readily coagulable by heat and acids, showing that it is essentially composed of albumen. The presence of the fluid is easily detected by the elastic and fluctuating character of the swelling, and very frequently a distinct friction sound and sensation can be perceived upon handling the tumor: if necessary, an exploring needle is used. The integument is free from discoloration, there is no enlargement of the subcutaneous veins, and the principal inconvenience experienced by the patient is of a mechanical nature. Now and then there is a good deal of pain, but more generally simply a sense of soreness and stiffness.

The size and shape of the tumor formed by these dropsical collections are subject to great diversity ; in general, it does not exceed the volume of an orange, or a goose's egg, but cases occur in which it reaches the bulk of a fœtal head, although this is very uncommon. Its shape is generally irregularly rounded or ovoidal, with a compressed, flattened appearance.

Dropsy of the synovial pouches may often be relieved, in its earlier stages, by the diligent application of iodine, astringent and sorbefacient lotions, and, above all, by blisters, conjoined, with rest, attention to the bowels, and the use of the bandage. In cases of long standing, however, such treatment is seldom of any permanent advantage, nothing short of a complete and radical change in the action of the secernent vessels answering the purpose. With this view, the water being drawn off with a trocar, the same remedies may be adopted as in the treatment of hydrocele, that is, injections of stimulating fluids, as tincture of iodine, nitrate of silver, or iodide of iron; or, what I deem better, because more certain, the introduction of a small seton, retained for a period varying from three to six days, according to the amount of the resulting inflammation. In either case, the part is carefully kept at rest, and every precaution used to prevent undue morbid action. When the tumor has become solidified and nearly of its origi-

Fig. 261.

Fibroid Bodies of a Synovial Burse.

nal size, it is an evidence that the seton should be withdrawn. From three to six weeks will usually elapse before a complete cure is effected.

The operation by incision is sometimes practised in these dropsical accumulations ; but

as it is not only severe, but liable to be followed by violent inflammation, sometimes seriously implicating a neighboring joint, it should be abandoned.

4. Intermixed with the fluid above described, or occurring independently of it, there are occasionally *loose concretions*, of a dense, fibrous, fibro-cartilaginous, or cartilaginous consistence, of a light yellowish, grayish, or whitish color, and of a flat oval form, not unlike small melon seeds. Their number is sometimes very remarkable, upwards of fifty having been extracted from a single pouch. The adjoining sketch, fig. 261, affords a good idea of the appearances of these bodies, as they are exposed on dissection, and also of the changes which the burse has undergone in consequence of their presence. When existing in considerable numbers, a careful examination will rarely fail to detect their true character. The symptoms which they occasion are such as usually attend chronic bursitis. More or less of a friction feel is generally present, and cases occur in which the little bodies may readily be pushed about from one place to another.

How are these bodies formed? Two theories have been advanced upon the subject. According to one, they consist essentially of plastic matter, originally poured out in soft, amorphous granules or flakes, which, increasing in size and density, are gradually moulded into a determined shape by the pressure of the surrounding parts, as well as by the friction which they exert upon each other as they are pushed about from place to place in their confined situation. The other explanation is that they are originally connected to the inner surface of the sac, from which they receive temporary support and nourishment; but, finally becoming detached, by the constant friction to which they are subjected, they present themselves as loose bodies, of varying shape and consistence. The latter theory is favored by the results of dissection, which not unfrequently shows some of these bodies as still firmly adherent to the inner surface of the affected pouch, and by the analogy which exists between them and the concretions met with in some of the movable joints, which are, apparently, always formed in this manner.

The only way to get rid of these bodies is to effect their extrusion by free incision, a drainage tube being afterwards placed in the bottom of the sac, to promote its obliteration.

Bodies, closely resembling small *hydatids*, are occasionally found in these pouches. J. Cloquet met with an instance in which there were upwards of one hundred and forty, varying in size from one to three lines in diameter, nearly transparent, and of a lenticular shape. They were situated in the large burse between the great trochanter and the tendon of the gluteal muscle.

5. *Contusions* of the burses are produced by violent blows and falls, and are followed either by acute inflammation or by a collection of blood in their interior, which generally undergoes changes similar to those witnessed in an apoplectic effusion, terminating in a fibrinous mass of varying firmness and density. When the contusion has been very severe, the extravasated blood remains fluid, and is converted into a dark, grumous mass, of the consistence of syrup.

The tumor formed by the extravasated blood is easily recognized by its sudden development in the situation of a normal burse after external violence, by its well-defined, circumscribed form, and by ecchymosis of the surrounding parts. It is always soft and fluctuating at the beginning, and sometimes it retains this feature throughout, although it generally soon becomes comparatively firm and hard, from the coagulation of its contents. If the sac be not too much distended, the clots may be felt through its walls, and a very distinct crepitation may be elicited by crushing them between the fingers.

Accumulations of blood in the burses disappear spontaneously, or under very simple measures, as rest, refrigerant, astringent, and sorbefacient lotions, and systematic compression. If inflammation and suppuration set in, the sac must be laid open. When the case proves obstinate, subcutaneous evacuation, followed by compression, will be necessary.

SECT. IV.—APONEUROSES.

The aponeuroses, considered by themselves, offer very little of interest in a surgical point of view, since their diseases are not only infrequent, but very imperfectly understood. From the intimate relations which they sustain, on the one hand, to the muscles, and, on the other, to the connective tissue, it is obvious that there can be but few diseases or injuries, of a serious character, of these structures, without more or less mutual involvement. At the same time, it is evident that the aponeuroses, from their peculiar arrangement, must necessarily, in many cases, play a very important part in preventing the extension of morbid action to the muscles which they serve to inclose, just as the periosteum impedes the propagation of disease to bone, and, conversely, from bone to the

surrounding textures.   This barrier, of course, is often broken in both cases, and then the ravages of the morbid action will be likely to be both rapid and extensive, as we see exemplified in the worst forms of erysipelas, carbuncle, and other affections, in which every variety of structure is rudely and indiscriminately assailed by inflammation, not unfrequently terminating, in a few days, in the destruction of an entire limb.

Acute aponeurositis is an uncommon occurrence, and is chiefly observed as a consequence of external injury, or as an effect of erysipelas, carbuncle, and whitlow.   Gout and rheumatism are generally believed to be seated exclusively in the fibrous envelops of the muscles; but the probability is that the tendinous, ligamentous, and bursal structures are nearly always implicated along with them, the two diseases sometimes beginning in the former, and sometimes in the latter, but usually ultimately attacking all.

A bad form of inflammation of the aponeuroses is occasionally produced by punctured wounds, especially when occurring in the palm of the hand and the sole of the foot, in persons of broken constitution and dissipated habits, or nervous temperament.   The disease soon assumes an erysipelatous disposition, and leads to excessive suffering, both local and constitutional: occasionally it is followed by tetanus.   Inflammation of these structures manifests but little disposition to pass into suppuration, ulceration, or gangrene.

Chronic inflammation of the aponeuroses is much more common than the acute, and leads to various alterations of structure, as thickening, atrophy, induration, and contraction, often followed by serious, if not irremediable, deformity.   Sometimes they are affected with slight ossification, the new substance presenting itself in the form of bony spicules; and cases are met with in which, from long-continued pressure, they are remarkably attenuated, and pierced with numerous apertures, giving them a sieve-like appearance.

The treatment of aponeurositis is conducted upon ordinary antiphlogistic principles. Anodynes must be exhibited in full and repeated doses to relieve pain and nervous symptoms; if plethora exist, or the local action is very severe, blood must be taken from the arm and by leeches from the affected parts; the bowels must be freely moved; and recourse must be had to saline and antimonial medicines.   Free incisions are made if much tension is present, or the formation of matter is threatened; followed by medicated fomentations and emollient poultices.

Aponeurositis dependent upon a gouty, rheumatic, or syphilitic state of the system, must be managed according to the general principles of treatment laid down for the relief of these affections; by colchicum, iodide of potassium, and mercury, in combination with other suitable means.

Sarcomatous and fibrous tumors, especially the spindle-celled variety of the former, are frequently met with in connection with the aponeuroses.   The fact of this occurrence need only be mentioned, as they obey the same laws here as in other parts of the body.

CHAPTER III.

DISEASES AND INJURIES OF THE NERVES.

SECT. I.—WOUNDS AND CONTUSIONS.

NERVES that are divided readily unite, and, after the lapse of several months, their structure and functions are restored.   In order, however, that the connecting medium shall be useful, the interval between the two extremities must be very short, otherwise each end may become expanded into a bulbous mass, having all the characteristics of a neuromatous tumor, similar to that which occasionally forms in a stump after amputation, and liable, like it, to become the seat of neuralgia.   It is worthy of notice that a nerve, slowly divided with a ligature, will generally unite more rapidly and completely than one divided with a sharp knife; in the former case there is commonly very little retraction of the ends, whereas in the latter they sometimes separate to a considerable distance, thus requiring a larger quantity of new material to fill up the gap.

When a nerve is cut completely across, the parts to which it is distributed are necessarily deprived of their functions, an occurrence which, consequently, serves as a diagnos-

tic sign of the accident. Thus, if the nerve be one of motion, the parts will be paralyzed, while, if it be one of sensation, they will be divested of sensibility. If the division be only partial, the loss of function will, of course, be partial also. In general, the structures beyond the seat of injury feel numb and heavy, with a sense of tingling, prickling, stinging, or burning. When the section is complete, there is always a remarkable diminution of temperature in the parts supplied by the affected nerve, seldom amounting to less than six, eight, or ten degrees. The structures remain for a long time sore, tender, painful, and prone to inflammation, and eventually they become greatly atrophied. The capillary circulation is seriously disturbed ; the vessels are habitually congested, and the skin is of a pale, livid hue, and easily impressed by atmospheric changes. In cases of long standing, the papillæ of the skin waste and shrink, and there is a material decrease of tactile sensibility.

The recent observations and experiments of Létiévant, Arloing, Tripier, and others have shown that, " despite the division of a nerve, there always remains, in the parts it supplies, a certain amount of sensation, if it be a sensory nerve ; of motion, if it be a motory nerve ; or of both, if it be a mixed nerve." These functions, which are at first very imperfectly performed, gradually increase in power with the lapse of time, and are evidentally due to the agency of anastomotic nervous filaments, the restoration being the same in principle as the restoration of the circulation after the ligation of an artery. The paralysis which supervenes upon the division of a nerve of motion is ultimately followed, in every case, by more or less muscular atrophy. Sensation is relatively more marked than motion, but, like the latter, it never attains the normal standard, except when the ends of the divided nerve are completely reunited, and is liable to be influenced by accidental conditions, especially by inflammation and œdematous swelling.

Wounds of the nerves are treated upon the same general principles as wounds of other structures. When there is no serious loss of substance, the divided ends should be as closely approximated as possible by attention to position, and by suture of the neurilemma, introduced with a very fine needle. A suture will be particularly serviceable when a large trunk has been severed, or when there is inordinate tendency to separation in the ends of the cord. The operation is very simple, and, if carefully performed, almost free from pain. The best substance is the carbolized catgut ligature, the ends being cut off close.

A similar procedure may be adopted when a large nerve has been severed, but has failed to unite. An incision being made down to the nerve, the two ends are carefully retrenched, and then tacked together by several points of suture, apposition being favored by stretching of the nerve and by attention to the position of the parts in which it is contained.

Suturing of divided nerves was advocated in the first edition of this work, issued in 1859, and since then numerous cases have been reported in which the operation was attended with the most gratifying success. The operation, in fact, is now one of the established procedures in surgery. Experience has shown that no harm results when the suture is pushed through the entire thickness of the nerve, neurilemma and all.

Nerves, when *punctured*, pricked, or partially divided, usually occasion severe pain, of a neuralgic character, extending up and down the affected parts, and attended with muscular weakness, perverted sensation, convulsive movements, and derangement of the general health. Such effects not unfrequently follow venesection at the bend of the arm, from injury sustained by one of the subcutaneous nerves. The proper remedy is complete division of the affected filament, either subcutaneously, or, when this is impracticable, by free incision. The operation, however, is not always permanently successful, owing to the deep impression which the lesion has made upon the general system. Besides, the divided extremities of the nerve are very apt to take on diseased action, either by being incorporated in the original cicatrice, or by being expanded into a species of neuroma. When this is the case, the proper procedure will be free excision instead of subcutaneous section, the ends, if not too widely separated, being afterwards united by suture.

Severe effects often follow *contusion* of the nerves, the parts to which they are distributed becoming numb, cold, withered, more or less painful, and, ultimately, almost entirely useless. Effects of this kind sometimes succeed to accidents, apparently, of the most trifling character. The nerves, so far as an opinion can be formed without the light of dissection, soon become inflamed, and are often irretrievably ruined, being effectually and permanently disqualified for the performance of their functions. It is hardly probable that these effects are due, as has been conjectured, to mere concussion of the nerve-substance ; for, if this were so, they would be much more transient, as

well as less severe. What corroborates the idea that inflammation is deeply concerned in the production of the secondary suffering is the fact that the parts, although seriously crippled at the start, do not evince much derangement until the disease is established in all its intensity.

Concussion of the nerves has been very ably described by Professor Willard Parker, who considers the accident as similar to concussion of the brain, the nerves receiving a shock eventuating in a sudden suspension of their functions. In a paper upon the subject, in the New York Journal of Medicine for September, 1856, he has related six cases illustrative of the nature of the injury. When the paralysis, which is generally temporary, subsides, the affected nerves are in danger of being assailed by inflammation, which, if it cannot be prevented, must be treated in the usual antiphlogistic manner. A long time frequently elapses before recovery takes place, the nerves remaining weak, irritable, and incapable of performing their proper functions. The limb supplied by the affected cords is soon exhausted by exercise, and is the seat of a dull, aching, tired sensation, which is always aggravated by exertion, especially if carried beyond a given limit ; in time, it becomes cold, atrophied, and, in great degree, useless. The general health also suffers, although the disease never proves fatal.

The treatment, in the first instance, is by rest, absolute and unconditional ; and, after the nerves have recovered from the immediate effects of the injury, by passive exercise, by slapping with a fringed towel wrung out of iced water, followed by massage and dry friction, and by attention to the general health, which, in the more severe forms of the accident, is always materially, if not seriously, impaired.

Severe pain is often produced by *compression* of the nerves, without, so far as can be determined, any particular disease of the nerves themselves. In aneurism, for example, of the larger arteries, the patient often experiences extreme suffering from this cause. The pain, in this case, is either sharp and darting, as in certain forms of neuralgia, or of a burning, tearing, boring, or gnawing character, especially if there is at the same time erosion of the osseous and cartilaginous tissues.

When the nerves of the distal portion of an extremity are injured, the fingers and toes are peculiarly prone to suffer, becoming, at first, inflamed, swollen, glossy, œdematous, and excessively painful, and afterwards, as more remote effects, atrophied and deformed, with various eruptions, ulcers, disease of the nails, and desquamation of the cuticle. Such affections are always difficult to manage, and often resist every attempt at a perfect cure.

Finally, the nerves are occasionally the seat of *foreign bodies*, introduced during the infliction of wounds, which they thus serve to complicate. Various kinds of substances may thus be carried in, as portions of clothing, pieces of wood, glass, porcelain, or iron, and fragments of bone. Denmark has related a case in which part of a bullet was imbedded in the radial nerve ; and Dupuytren met with one in which the end of a lash was buried in the ulnar nerve.

The immediate effects of such accidents are violent pain, spasmodic contraction of the muscles, loss of appetite and sleep, and great disorder of the health. Tetanus and neuralgia are also sufficiently common. The slightest motion and pressure always aggravate the local suffering.

The only remedy is removal of the foreign body, the presence of which is generally indicated by the seat of the pain. Sometimes the substance may be distinctly felt with the finger. When the suffering persists, it may be necessary to excise a portion of the affected nerve.

SECT. II.—TUMORS.

Various kinds of tumors, as the myxomatous, fibrous, sarcomatous, fatty, and cystic, have been found in the nerves, but their occurrence is very uncommon, and their discrimination is not only difficult, but frequently impracticable. Such growths, which seldom attain much bulk, probably always begin in the interfibrillar connective tissue, from which, as their development proceeds, they gradually extend to, and ultimately more or less seriously involve, the proper substance of these cords. The neuromatous tumors, described in a previous chapter, consist mainly of myelenic and amyelenic fibres. Cysts, occupied by a gelatiniform, serous, hematoid, calcareous, or osseous substance, have been met with in different nerves, especially in the larger trunks of the extremities.

Mr. C. H. Moore, of London, in 1866, described a very curious case, perfectly unique

in character, of arterio-venous tumor of the popliteal nerve, in a woman, thirty-one years of age, who had been struck in the middle of the ham with an iron pump-handle. It presented itself in the form of a vast cyst, shaped like a double cone, occupied by serum, black clots, and loose fibrin, interspersed with small clusters of white corpuscles, and consisted essentially of an expanded and hypertrophied condition of the component elements of the nerve, the fibres of which were disparted in such a manner as to resemble, in their mode of arrangement, the fleshy columns of the heart. The inner surface of the cyst had a smooth, shining appearance, and was marked by two orifices, one representing a large vein, and the other a small artery, which had thus poured their contents into the interior of the sac. When Mr. Moore first saw the case, nearly two years after the accident, the tumor completely filled the ham, and projected backwards in two prominent lesser swellings, which seemed to be partly fluid and partly solid, and which might have been mistaken for a large burse, so liable to form in this situation. The tumor was exquisitely tender on pressure, as well as the seat of severe pain, and violent pain, with a sense of tingling, was also felt in the leg and foot. An exploratory incision revealed the true nature of the disease, but as the cyst could not be dissected out, and as it would have been improper, on account of the woman's health, to allow it to suppurate, amputation was at once performed, and life thus preserved.

Bertrand met with a cystic tumor in the upper part of the median nerve, of the size of a hen's egg, in a man eighty years of age. It had never occasioned any pain, and was filled with sanguinolent fluid, intermixed with clots of blood.

The treatment of these tumors, whether benign or malignant, resolves itself into three distinct procedures:—1st, the removal of the morbid structure by a careful and patient dissection, with as little disturbance as possible of the proper nerve substance; 2dly, the excision of the affected portion of the nerve; and, 3dly, amputation of the limb. The first of these procedures would, for obvious reasons, be inapplicable to malignant growths, and the second could not be performed with safety when the tumor, benign or malignant, involves one of the principal nervous trunks of an extremity, as the operation might be followed not only by serious paralysis, but by extensive, if not fatal, mortification. Amputation should never be performed, unless it has been clearly ascertained, by a most careful inspection of the morbid mass, that it is the only available expedient. In a case recorded by Moutard-Martin excision of a malignant tumor of the median nerve was followed by the development in the brain of a similar growth, which caused the death of the patient.

SECT. III.—TETANUS.

The term tetanus is a generic one, employed to denote a peculiar affection of the nerves, characterized by violent contraction of the voluntary muscles, with irregular intervals of partial, although seldom of complete, relaxation. Different names have been devised to designate the disease, according to the nature of the predominant local symptoms occasioned by the affected muscles. Thus, when the muscles of the lower jaw are spasmodically contracted, so as to prevent the patient from opening his mouth, the word *trismus* is employed; or, to use a common expression, the person is said to have locked jaw. When the body is bent forcibly forwards by the action of the abdominal muscles, the affection is denominated *emprosthotonos*, and *opisthotonos* when it is drawn backwards by the dorsal muscles. The term *pleurothotonos* is used when the body is drawn to one side, which, however, is a very rare occurrence. A distinction of much greater importance is that of tetanus into traumatic and idiopathic, acute and chronic. The disease occasionally comes on within a few days after birth, and is then designated as infantile tetanus, the *trismus nascentium* of authors.

In this country, especially in its more temperate latitudes, the surgeon has to deal chiefly with traumatic tetanus, the idiopathic variety being extremely infrequent. Cases of it, however, occasionally occur in the more tropical States of the Union, especially in South Carolina, Georgia, Mississippi, Florida, Louisiana, and Texas; while in the West and East Indies it is sufficiently common. The tetanus of new-born infants is met with chiefly in the southern and southwestern States of North America, in consequence, apparently, of injury sustained in the ligation of the umbilical cord. Infantile tetanus seems to have at one time been very common in certain portions of Europe. Thus, it is asserted by Dr. Joseph Clark, that in the year 1782, of 17,550 children born in the Lying-in Hospital of Dublin, 2944 perished from this cause alone within the first fortnight after birth.

Traumatic tetanus, to which the ensuing remarks are more particularly intended to

apply, is not peculiar to any age or to any particular pursuit ; but is met with at all periods of life and in all classes of society. The young, however, suffer more frequently than the aged, and it is particularly liable to occur in persons of a nervous, irritable temperament. Ill health, especially disorder of the digestive apparatus, grief, anxiety of mind, and whatever has a tendency to depress the energies of the system, powerfully predispose to its development. Women are quite as liable to the disease as men, but the greatest number of cases occur among the latter because they are much more exposed to its exciting causes. Blacks and mullattoes suffer more frequently from tetanus than whites. In some portions of the West Indies the disease is almost exclusively confined to the colored population.

Traumatic tetanus occasionally assumes an epidemic tendency. In 1858, numerous cases of the disease appeared in rapid succession in several of the London hospitals, the attack having often followed upon the most trivial injuries and operations, as the ligation of a hemorrhoidal tumor or the amputation of a finger. In one of these institutions not less than nine deaths occurred from tetanus within two months.

Causes.—The causes of traumatic tetanus are, as the term implies, various kinds of external injury, as punctured, lacerated, contused, and gunshot wounds, burns, scalds, abrasions, compound fractures and dislocations, and surgical operations, as amputations and the excision of tumors. A number of cases have been recorded in which tetanus was produced by salivation. Some of the most trivial accidents are, at times, sufficient to occasion the disease. Thus, cases have been observed in which it followed the application of the scarificator in cupping, the introduction of a seton, and the extraction of a tooth. In three cases of tetanus under the care of Dr. Richard J. Levis, at the Philadelphia Hospital, the disease, in one, was occasioned by a slight scald of the back of the hand and wrist ; in the second, by frost-bite of the feet, and, in the third, by several Vienna paste issues made for the cure of varicose veins of the leg. Dr. John Lodge has mentioned to me the case of a youth, fourteen years of age, who died from locked jaw, caused by a slight scratch on the ball of the thumb, received three weeks previously. Baron Larrey has recorded an instance in which it was caused by the lodgment of a fish bone in the fauces. Examples of tetanus, consequent upon the ligation of the iliac, femoral, and carotid arteries, have been recorded by Brodie, Dazille, and Dudley. I have met with it as an effect of the injection of a hydrocele ; now and then it follows upon parturition. The fact is, in persons of a nervous, irritable temperament, any injury, however trifling, may readily induce the affection, especially in hot and damp states of the atmosphere, or during sudden transitions from heat to cold. Exposure to cold draughts, by which the body is suddenly chilled, is, under such circumstances, extremely liable to provoke an attack.

In our larger cities numerous cases of tetanus have of late years been caused by injuries inflicted with the " toy pistol" during our 4th of July celebrations, at the time when the thermometer was high up in the nineties. Of the many persons, chiefly boys, that were wounded in Philadelphia, on that day, in 1880, thirty-three, as I am informed by Dr. J. Sabastian Miller, perished from this disease, most of them within the first ten days. The lesions were in almost every instance inflicted upon the fingers, and the majority of them were apparently of a very insignificant character. The average duration of the cases was about ten days. In Baltimore, in July, 1881, upwards of twenty fatal cases of tetanus occurred from this cause.

The influence of injuries upon the production of tetanus is apparently much less than is generally supposed. Thus, of 3668 cases of operations, large and small, wounds of all kinds, injuries and contusions, burns and scalds, and compound fractures, treated at Guy's Hospital during a period of seven years, only 23, according to Mr. Poland, suffered from this disease.

The effect of cold air, when permitted to play directly upon the body, is well illustrated by what occurred after the battle of Ticonderoga, in 1758. The wounded were exposed the whole night after the action, in open boats upon Lake George, and the consequence was that nine of them died of locked jaw. During our war with Great Britain, most of those wounded by fire-arms on board the frigate Amazon, before Charleston, were attacked with tetanus on the fourteenth day, from a sudden change of very wet and cold weather following a long drought. Wounded soldiers lying on damp or wet ground, are particularly prone to attacks of this disease. Thus, after the battle of Bautzen, where the men were left all night on the field, exposed to severe cold, more than 100 were seized with tetanus ; and similar effects were witnessed after the engagement at Dresden, from the suffering induced by the sudden transition from a hot to a cold, chilly atmosphere.

The injury inducing the disease may be situated upon any part of the body. It was at one time supposed that lesions of the head and face were singularly exempt from tetanus, but more enlarged experience has demonstrated that, although it does not occur with the

same relative frequency as when the cause is seated in other regions, yet its invasion after such accidents is by no means uncommon. Injury of the inferior extremity is more prone to be followed by tetanus than a similar affection of the superior extremity; and everybody knows how remarkably liable the disease is to supervene upon wounds involving the tendons and aponeuroses of the hands and feet, especially of the latter. Lesions of the nerves themselves are peculiarly dangerous in this respect, more particularly when they are of a punctured character, or when they are limited to a partial division of their fibres and neurilemma, by a blunt instrument, as a piece of glass or a rusty knife. Fatal cases of tetanus from the ligation of nerves have been reported by Larrey and other surgeons.

The extent of the injury does not, so far as can be judged, exert any material influence upon the production of the disease, as it has been known to follow, on the one hand, the most insignificant scratch, and, on the other, the most frightful wound. I believe, in fact, that it may be assumed, as a general principle, that the danger of the occurrence of tetanus is, other things being equal, almost in direct ratio to the diminutive size of a wound. This is certainly true of a majority of the cases that have fallen under my personal observation, an apparently trivial injury, mostly a little puncture, having served as the exciting cause.

Symptoms.—The period which intervenes between the occurrence of the injury and the development of the disease is liable to considerable variety. Generally it ranges from four to ten days. In some instances well-marked symptoms supervene within several hours after the receipt of the injury; and, on the other hand, the attack may not occur under eight or ten weeks. In rare instances the disease does not appear until after the wound that provoked it is completely closed, owing, doubtless, to some lurking irritation in the nerves of the affected parts, or to the retention of some foreign substance.

Although tetanus may come on suddenly, with hardly any premonition, yet, in general, the attack is preceded by various anomalous nervous sensations which but too clearly foreshadow its approach. The most important and reliable of these precursories are, a feeling of malaise or universal uneasiness, aching in the muscles, stiffness about the lower jaw, pain in moving the head, and difficulty in protruding the tongue. The wound, if any exist, commonly puts on an unhealthy appearance, discharging a thin, sanious fluid, and manifesting no further disposition to heal. After these symptoms, which are often attributed by the patient to the effects of cold, have continued for a variable, but usually a very short, period, others, more bold and decisive in their character, set in, leaving no longer any doubt respecting their true nature. The jaw now becomes firmly locked; the faculty of mastication is completely abolished; attempts at deglutition excite spasm in the throat, with a sense of impending suffocation; and there is an indescribable distress in the precordial region, extending from the ensiform cartilage backwards towards the spine,

Fig. 262.

Opisthotonos.

as if the chest were tightly encircled by a cord. The muscles of the back and abdomen are rigidly contracted, and, in no long time, those of the extremities become similarly affected. When their action is very violent, the spinal muscles may shorten themselves so much as to draw the trunk into a distinct arch, the body resting only upon the occiput and heels, the affection thus constituting the variety of tetanus called opisthotonos, illus-

trated in fig. 262, from Bell. The opposite state of this, emprosthotonos, is extremely uncommon; for, although the abdominal muscles are usually very firmly contracted, being often as hard as a board, yet it is seldom that they are able to counteract the extensor muscles of the back to such a degree as to bend the head and chest forwards. The disease having reached this stage, may be said to be completely and characteristically established. Frequent spasms now occur, convulsing and agitating the whole frame, and greatly increasing the general suffering. The teeth are firmly clenched; the eyes are fixed in their sockets, and have a wild, unnatural expression; the nostrils are expanded; the corners of the mouth are retracted; the countenance has an old, haggard, and withered look; the respiration is laborious and hurried; and the smallest quantity of fluid is unable to descend the fauces and œsophagus. So great, in fact, generally, is the impediment to deglutition, that the very sight of water is a source of suffering. The pain is usually severe, particularly about the jaw, throat, chest, and spine; while the general sensibility of the surface is so excessive that the slightest breath of air is often sufficient to bring on violent spasms.

Fever is seldom present in traumatic tetanus, even when it has reached its height, although the thirst is generally very considerable; the pulse, which rarely exceeds eighty, eighty-five, or ninety in the minute, is soft and regular, except, perhaps, during the violence of the muscular spasms, when it may be considerably agitated, small, and feeble; the tongue, at first moist, becomes gradually dry and brownish; the stomach is extremely torpid; the bowels are generally obstinately constipated; the urine is scanty and high-colored; and the skin is hot and bathed with a copious perspiration, which is occasionally very clammy and offensive, especially towards the latter stages of the disease. The mind is usually unimpaired.

Although such is the most common course of the disease, yet more or less irregularity occasionally arises, giving the symptoms somewhat of an anomalous character. Thus, there may be little or no pain; the throat may be free from uneasiness; the respiration may be gasping, or performed with a sort of catch; the eyelids may be half closed and the ball fixed; the orbicular muscle of the mouth may be firmly contracted over the teeth; and the extremities may remain completely relaxed and powerless. Epilepsy, hysteria, and delirium are sometimes noticed. The skin is, occasionally, remarkably hot, the temperature in the axilla, in some cases, having been found to range as high as 100°, 110° and even 112° Fahr. A complete remission of the symptoms is one of the anomalies of the disease, extending sometimes over a period of several weeks, as in an instance reported by Dupuytren. Duval refers to several cases in which the disease assumed the form of an irregular ague; and Mr. Morgan, of London, saw two patients in whom the spasm, instead of affecting the muscles of the jaw, primarily attacked the muscles of the part injured. I recently attended, with Professor Wallace and Dr. George T. Barker, a young lady of seventeen, who, in consequence of severe irritation of the upper jaw, arising from disease of one of the canine teeth, was seized with tetanic symptoms, attended with locked jaw, pain in the epigastrium, back of the neck, face, and lumbar region, and the most violent opisthotonos. The paroxysms during the first twenty-four hours recurred with great frequency, often, indeed, every five or ten minutes, but afterwards, under the influence of hypodermic injections of morphia, aided by the use of chloral and quinine, they became less frequent, although they did not completely disappear under several weeks. The peculiar feature in this case was the entire absence of locked jaw during the intervals of the paroxysms, the attack having evidently been one of hysteria associated with tetanus.

Diagnosis.—The diagnosis of tetanus rarely, if ever, presents any difficulties. In general, the history of the case alone is quite sufficient to determine its true character. The only disease with which it can be confounded is hydrophobia, but the symptoms of the two affections are so very different that none but the most heedless practitioner could possibly commit such an error. The period of latency in hydrophobia is, on an average, not less than a month, while tetanus is usually developed in from five to fourteen days from the infliction of the injury which provokes it. Besides, in rabies there is an absence of locked jaw and of opisthotonos, which constitute such striking features in tetanus.

One of the most valuable diagnostic symptoms of tetanus is the terrible distress in the precordium; it is usually described as of a painful, dragging nature, and is no doubt dependent upon spasmodic contraction of the diaphragm. Coming on early in the disease, it generally continues to its close, and is nearly always attended with opisthotonos, the head and shoulders being drawn, as it were, instinctively backward, to relieve pain and to favor the introduction of air into the lungs. In tetanus, the muscular contraction is steady and persistent, although liable to frequent and sudden exacerbations; in hydrophobia

it is clonic, occurring paroxysmally, and having distinct intermissions. In tetanus, swallowing is difficult, chiefly by reason of the impossibility of separating the jaws; in rabies, it is dependent upon spasm of the throat and œsophagus; in the former, the mind is calm and unaffected; in the latter, it is often powerfully excited, and, at times, even furious.

Tetanus, especially in its chronic form, has sometimes been mistaken for rheumatism, from which, however, it is always readily distinguishable by the history of the case and the absence of spasm in the muscles of the jaw.

Poisoning by strychnia closely simulates tetanus. There is, however, no locked jaw; the patient is able to open his mouth and swallow; the agitation, trembling, and convulsions are more violent; the symptoms come on suddenly, and rapidly disappear when the dose is small, or death soon occurs when the quantity is large.

Prognosis.—The prognosis in traumatic tetanus is extremely unfavorable. In the great majority of cases death occurs from the third to the fifth day; and if an instance of recovery is occasionally met with, it only goes to confirm the general law of the mortality of this affection. In an experience of fifty years, I have seen but three cases where the patient escaped with his life, and then only after a protracted and painful struggle. When the disease has once fairly commenced, the tetanic spasms generally continue to recur, with more or less severity, until they prove fatal. There are no reliable signs which can serve to guide us in regard to the prognosis in this affection. The previous state of the general health, the age of the patient, and the character of the pulse, afford no clue as to the probable issue of the case. The young and the robust fare no better, in this respect, than the old and infirm. Both alike perish from its attacks. The danger is undoubtedly always, other things being equal, in proportion to the violence and duration of the paroxysms, and it has been found that any tendency to chronicity is generally so much in favor of ultimate recovery; although patients sometimes live for several weeks, and then die from the effects of the malady.

Of 415 cases of this disease tabulated by the late Dr. R. O. Cowling, of Louisville, Kentucky, 233 recovered, and 182 died, the mortality being greatest in children under ten years of age, and least between ten and twenty years. Professor D. W. Yandell, from a careful analysis of these cases, finds that persons are most likely to recover from acute tetanus when the attack occurs subsequent to the ninth day after the injury, and that, when the symptoms have lasted fourteen days, restoration is the rule, and death the exception, apparently independently of the treatment. Of 363 cases of traumatic tetanus that occurred during our late war, 336 terminated fatally. Of 27 reported cures, the disease was of a chronic character in 23.

The manner in which death occurs is not well understood. In some instances it is, apparently, caused by suffocation, from spasm of the muscles of the larynx; occasionally it results from mere exhaustion, life being worn out by the intensity of the suffering; and in a third class of cases it may probably be induced by spasm of the heart, interrupting the passage of the blood to the lungs and brain.

Pathology.—It might reasonably be supposed that a disease which is characterized by so much violence during life, would leave some traces of its existence after death; but, to show how erroneous such a conclusion is, it is only necessary to refer to the fact that all the dissections that have hitherto been made of persons dead of this affection have utterly failed to throw any satisfactory light upon its pathology and morbid anatomy. Many statements have been reported with reference to these dissections that are entirely without foundation; in fact, in not a few of the cases, natural or accidental appearances have been confounded with morbid, and lesions have been described which existed only in the imagination of the examiners. From the circumstance that tetanus is essentially a nervous affection, the brain and spinal cord, as well as the nerves emanating from them, and even the great sympathetic, with its plexuses and ganglia, have all been most thoroughly scrutinized in numerous instances, and that, too, by some of the ablest men in the profession, and yet, notwithstanding all this, we are no wiser now in regard to the actual lesions of this disease than surgeons were centuries ago. The whole subject is, in truth, still a mystery. I have myself made several dissections of this kind, and have witnessed others, amounting, perhaps, altogether to eight or ten, without having, in a single one, observed any morbid appearances that could justly be ascribed to the effects of the disease. It has been noticed in several instances that the nerves leading from the wound which caused the attack were in a state of inflammation, their substance and neurilemma being congested and discolored.

Of the true pathology of tetanus, then, nothing whatever of a satisfactory nature is

known; that it is essentially an affection of the nervous system, or of the nerves of particular muscles, must be admitted from the symptoms which characterize it; but in what the peculiar change consists, and to what extent it is carried, are points in the history of the lesion of which we are completely ignorant.

Treatment.—The treatment of this obstinate, and, unfortunately, too generally fatal, disease, is altogether of an empirical character. That this should be so is not surprising, when it is remembered how completely ignorant we are of its pathology, and the fact that there is hardly an article of the materia medica, of any reputed efficacy, that has not been employed, either singly, or in various forms and modes of combination, for its relief. Although patients occasionally get well of this disease, under circumstances, apparently, the most desperate, yet, when the practitioner comes to analyze his treatment, in the true spirit of philosophy, he is generally compelled to confess his ignorance as to the share which his remedies may have exerted upon the fortunate event, and to acknowledge that accident, rather than his own skill, performed the cure. However this may be, it is certain that the disease sometimes either wears itself out, or yields to the most insignificant measures, while at other times it resists the best directed efforts of the ablest and most experienced practitioner. The chances, indeed, of effecting any good, when the malady is fairly established, are very slender in any case, however mild. Hence, whatever is done should be done promptly, and with a view to a prophylactic rather than to a curative result.

One of the first and most important indications in traumatic tetanus is the removal, if possible, of the exciting cause, which is, of itself, occasionally sufficient to effect a cure. Thus, if any foreign body remain in the wound, or in contact with the living tissues, the surgeon cannot too speedily extract it, especially if there is already some evidence of approaching disease. Sometimes a vicious cicatrice may keep up the tetanic irritation. Many years ago, I attended, in consultation with Dr. Buck, a young girl of fourteen, who had locked jaw from having been accidentally hurt, nearly a month previously, in the right cheek, by a small splinter of wood. Although the substance was immediately extracted, yet the parts continued to be tender, being, at times, even quite painful, and in less than a week tetanus set in. When I saw the case, free use had already been made, without any material benefit, of anodynes and antispasmodics, along with an occasional purgative, and the cheek had been leeched and repeatedly painted with iodine. The girl was pale and feeble, and had lost her appetite. Upon examining the original site of the injury, I found a small, circumscribed spot, exquisitely tender under pressure, and of almost fibro-cartilaginous hardness. This being carefully dissected out, no more paroxysms occurred; and in a few days, with the aid of iron and quinine, wine, and a generous diet, complete recovery ensued.

Amputation of the wounded part has occasionally been performed; and, judging from the statistics that have been published upon the subject, there is reason to believe that the operation has now and then proved successful. Nevertheless, few surgeons would, probably, be found to be so venturous as to remove a leg or an arm on the approach of such a disease, and none certainly would be foolish enough to attempt the expedient after it is fully established. In the one case, the possibility is that the affection might yield to other and milder means; and, in the other, as the disease is no longer one of a local character, but diffused, as it were, through the system, it is difficult to see how amputation, however early performed, could be of any benefit in arresting the morbid action, unless it be upon the principle of substituting a fresh and clean wound for one of an inflamed and irritable character. An interesting case, bearing directly upon this point, fell under my observation, in a patient of Dr. Mattingly, of Kentucky. The man, who was fifty years of age, was a stout, healthy farmer, of a nervo-sanguineous temperament, who, about five weeks previously, had the fore and middle fingers of the right hand, between the second and third joints, severely mashed by the passage of the wheel of a wagon, the phalanges being completely comminuted, and supported merely by a few shreds of integument. A physician, shortly after the accident, removed the injured parts with the scissors, and, binding up the ill-formed stumps, sent the man home, a distance of thirty-five miles. Excessive pain soon ensued, followed, at the expiration of the time above specified, by well-marked symptoms of tetanus. Five days after this, while the patient was under the influence of chloroform, I removed the mutilated fingers at the metacarpo-phalangeal joints, the whole hand being at the time much swollen and exquisitely tender, the tongue coated, the pulse hard and accelerated, and the system irritable from the want of sleep. The tetanic spasms continued for several days after the operation, but they became gradually lighter, shorter, and less frequent, and in a few weeks all symptoms of the disease had entirely disappeared.

How far the recovery in this case was due to the amputation of the affected fingers, it would be difficult to determine; but it is reasonable to suppose that the operation was serviceable by ridding the system of a mass of irritation and disease, which, if it had been permitted to continue, might have proved highly detrimental, if not destructive, to the patient.

In regard to the treatment of the wound itself, it cannot be doubted that prompt attention to it is of great moment. The remedies should generally be of the most soothing character, consisting of warm water-dressing, or emollient cataplasms, with a liberal admixture of laudanum, powdered opium, or, what is better than either, sulphate of morphia. If the parts are girded by inflammatory engorgement, or various kinds of deposits, as will be likely to be the case when the wound is of a punctured character, free incisions must be made, the knife being carried thoroughly through the tissues in every direction. A similar method should be adopted when there is reason for suspecting the lodgment of foreign matter. The practice, at one time so common, and, perhaps, not yet sufficiently exploded, of pouring irritating fluids into the wound, or of applying escharotics, cannot be too severely censured, as it must inevitably increase the suffering, and aggravate the disease.

I have no experience with excision of the nerves connected with the injured structures; an operation said to have sometimes been successfully performed by foreign surgeons. Such a step could only be justified in the case of the smaller nerves, and then, I presume, all the good that would be likely to accrue from it might readily be accomplished by the free division of the affected parts. Excision of the larger nerves might be followed by permanent paralysis. Stretching the nerves has occasionally succeeded in traumatic tetanus, and is worthy of further trial.

The patient must be carefully protected from the contact of cold air. Exposure of the body to a direct current is often, of itself, sufficient to bring on an attack of tetanus in a susceptible, nervous person; and, after the attack is fairly established, such an occurrence never fails to aggravate the spasms, rendering them both more frequent and violent. The atmosphere of the room should, moreover, be perfectly warm and dry, experience having shown that cold and moisture combined are extremely prejudicial in all affections of this description.

The most important internal remedies, undoubtedly, are anodynes and antispasmodics, of which opium, chloroform, Calabar bean, tartar emetic, aconite, camphor, assafœtida, and Indian hemp occupy the highest rank. They should be administered in large doses, with a view to an immediate and decided impression upon the general system, and should be given either by themselves or in various states and degrees of combination.

The most eligible preparations of opium are the acetated tincture and the salts of morphia, particularly the sulphate. Opium in substance is objectionable, on account of its insolubility, the stomach, under such circumstances, being extremely torpid, and unable to act upon it. For the same reason, a much larger quantity of laudanum and morphia is required to produce their specific effect than in ordinary diseases. If the patient be young and robust, or when the spasms are violent and obstinate, the anodyne should be combined with tartar emetic, in doses sufficiently large to relax the system. The latter remedy is sometimes employed by itself, and cases have come under my observation where it seemed to have effected a complete cure. I am satisfied, however, that its efficacy will always be materially enhanced by its judicious combination with morphia. The most prompt and efficacious method of administering morphia is by hypodermic injection, from a third to half a grain being thus introduced, either alone, or in union with the fiftieth of a grain of atropia, two or three times in the twenty-four hours, according to the violence of the suffering.

Aconite is a medicine of great efficacy as a depressant, and may be given as an adjuvant to morphia, or morphia and tartar emetic, in cases of tetanus attended with a robust and plethoric state of the system. It lowers the action of the heart, promotes perspiration, and relieves spasm. Veratrum viride acts in a similar manner.

Camphor and assafœtida, administered in large doses, occasionally aid in controlling the spasms in this disease, but they should never be trusted in alone. Their influence, as antispasmodics, is far inferior to that of morphia and tartar emetic.

Indian hemp, soon after its first introduction into practice, received a large share of attention in the treatment of this disease, especially from the East India practitioners, some of whom were at one time disposed to regard it as a specific. Subsequent experience, however, has greatly disappointed these expectations, and in this country very little,

if any, confidence is placed in the remedy. I certainly have never derived any appreciable benefit from it in the few cases of tetanus in which I have employed it, although the trials in each were very fair. The preparation usually given is the extract, in doses varying from one to two grains, repeated every two hours, or even more frequently, the object being the production and maintenance of narcotism.

The Calabar bean has been repeatedly employed in the treatment of tetanus, and cases have been reported in which its use was apparently followed by a complete cure. Its virtues, however, have undoubtedly been greatly overrated, and in two cases in which I made trial of it no appreciable benefit whatever resulted. The best form of the medicine is the extract, given in doses of one grain every two, three, or four hours, according to the violence of the symptoms.

Professor Christopher Johnston, of Baltimore, has reported several cases of traumatic tetanus, treated successfully with hypodermic injections of conia. His formula consisted of two drops of conia with one of sulphuric acid in one drachm of water, of which fifteen drops were introduced every two hours, day and night. In two other cases, one caused by gangrene from frost-bite, and the other by syphilitic ulcers of the leg, although the attacks were fatal, the remedy exerted a powerful influence in controlling spasm and muscular rigidity. Successful results have also been ascribed to the exhibition of gelsemium, tobacco, nitrite of amyl, and bromide of potassium.

Chloroform, administered internally, or inhaled in the form of vapor, has been much employed in this disease, and cases said to have been successfully treated by it have been reported by different observers, but how far they were really relieved by it is not determined. It is, however, certain that it generally signally fails to cure, and that it is of use chiefly in assuaging pain and spasm.

Much comfort is often experienced from the use of the vapor bath in the treatment of tetanus; the steam should be conveyed, by means of a tube, from the spout of a tea-kettle, or other suitable apparatus, under the bedclothes, and may be advantageously medicated with laudanum, or laudanum and chloroform. The remedy possesses no curative agency.

In my own hands nothing has afforded so much relief in mitigating suffering and preventing pain and spasm as quinine, combined with morphia, and given in doses of three to five grains every three or four hours. Other practitioners have found it equally valuable in this respect. Chloral, administered more or less freely, often acts beneficially in promoting sleep and preventing spasm. Even a cure is occasionally, at least apparently, effected by this agent; I say apparently, because in most of the recorded cases it is difficult, if not impossible, to eliminate the effects of chloral from those of other remedies. Dr. John B. Roberts, in 1877, published a table of nineteen cases of traumatic tetanus, treated with hydrate of chloral, in the Pennsylvania Hospital, of which sixteen perished, and three recovered. The remedy deserves further trial in this disease.

Bloodletting and mercury, the latter carried to the effect of salivation, were at one time much vaunted on account of their supposed efficacy in the treatment of tetanus. They have, however, of late years, been entirely abandoned. The patient is certainly reduced sufficiently soon without venesection; and as to mercury, its use has occasionally, as stated elsewhere, been followed by the very disease which it was intended to cure, the saliva streaming at the time from the mouth in enormous quantities.

When much exhaustion exists, the use of brandy, wine, and a generous diet is indicated, along with quinine and other corroborants. Rectal alimentation must be employed when the patient is unable to swallow. The profuse and exhausting sweats so often attendant upon the disease are best controlled by atropia or atropia and aromatic sulphuric acid, and by frequent sponging of the surface with a strong solution of alum.

Whatever treatment may be adopted, proper attention should be paid to the bowels, which are generally excessively torpid, and, consequently, difficult to be moved. When the patient is in a condition to swallow, he may take ten grains of calomel, with double that quantity of jalap, every six hours, until there are free alvine evacuations. If the medicines are tardy in their action, the operation may be promoted by the addition of a drop of croton oil, or by means of a stimulating injection, as spirit of turpentine and castor oil. Occasionally, croton oil may advantageously be rubbed upon the abdomen. Severe purging must be carefully avoided, as, from its irritating and prostrating effects, it cannot fail to aggravate the complaint.

The treatment of tetanus by counterirritation is, in great degree, obsolete. It was formerly thought, when the disease was supposed to be essentially connected with inflammation of the cerebro-spinal axis, that extensive and rapid vesication of the spine would

afford valuable aid in combating the morbid action, and putting a stop to the spasms; and examples illustrative of the beneficial effects of this mode of treatment have been published by different observers. The remedy usually selected is either the common blister, hydrate of potassium, or the actual cautery. The late Dr. Hartshorne, of this city, was in the habit of employing a solution of hydrate of potassium, in the proportion of one drachm and a half to two fluidounces of distilled water. It produces a powerful rubefacient effect, and may be applied by means of a cloth mop to a narrow line of skin, from the occiput to the sacrum. If the hot iron be used, it should be applied transcurrently. I have, however, great doubts in regard to the propriety of any measures of this kind, believing that they frequently aggravate the symptoms instead of relieving them.

When the disease is chronic, and there is a wound which is still open, but indisposed to heal, the best plan is to divide the parts freely with the knife, so as to relieve them of engorgement, and invite a more salutary action. It is under such circumstances that the actual cautery occasionally answers a good purpose. In a case in the practice of Dr. W. D. Stewart, of Indiana, the particulars of which he has kindly communicated to me, an immediate stop was put to the paroxysms by this procedure, after various other means had been fruitlessly tried for nearly a fortnight. No spasms took place after the application, and the patient, a lad nine years of age, made a prompt and perfect recovery. The wound which had provoked the attack was a large lacerated one, occupying the right side of the scalp, and extending down to the bones.

Anodyne and stimulating liniments, strong veratria ointment, and ice-bags applied along the spine, have sometimes acted beneficially, both in moderating the spasms and in eradicating the disease. Chloroform has also been used a good deal in this manner, and cases of its successful employment have been reported; among others, a very interesting one, by Dr. Hinkle, of Pennsylvania, of a woman who suffered from tetanus from the bite of an eel. The treatment was conjoined with purgatives and antispasmodics, as cannabis Indica, valerian, and compound sulphuric ether.

Finally, if the patient be so fortunate as to survive the disease, the greatest care must be observed during his convalescence, lest relapse occur and destroy him, when he is apparently on the verge of returning health. The clothing should be warm, the diet light but nutritious, the bowels and secretions duly regulated, and exposure to atmospheric vicissitudes sedulously avoided.

After all that has been done by modern science for the cure of traumatic tetanus, the humiliating fact stares us in the face that, of the many remedies that have been paraded before the profession, there is not one that is worthy of special confidence. An analysis of the cases tabulated by Dr. Cowling clearly shows, as Professor Yandell very justly remarks, that the results of treatment by different remedies are so nearly alike that no one agent can properly be considered as possessing any decided superiority over any other. All, in fact, are equally of apocryphal virtue.

SECT. IV.—NEURALGIA.

Neuralgia is an affection of the nerves attended with severe, agonizing pain, often paroxysmal in its character, liable to occur in all parts of the body, and generally dependent upon some local irritation, or upon the joint agency of a local and constitutional cause. As it would be out of place in a work of this kind to treat of neuralgia in general, I shall limit my remarks here chiefly to the disease as it manifests itself in certain nerves, particularly those about the face, where the lesion not unfrequently becomes the subject of surgical interference.

The causes of neuralgia are various and of the most opposite character. They are predisposing and exciting. Persons of a nervous, irritable, or hysterical temperament are more prone to the disease than any other class of individuals. The gouty and rheumatic also frequently suffer from it. Depressing influences, whether mental or corporeal, are among its most common predisposing causes. Dyspepsia and anemia, by lowering the powers of the system, remarkably favor its development.

The disease occurs in both sexes, at all ages, and at all seasons; it is most common, however, from the twentieth to the fiftieth year, and in winter and spring, in cold northern regions, and in districts abounding in malarial exhalations. Cold and damp states of the atmosphere are especially favorable to its production. Like gout and rheumatism, the disease occasionally manifests a hereditary predisposition, and in a number of instances I have met with it in several members of the same family. No parts of the body are exempt from its attacks. It is particularly frequent in the head,

face, and jaws. The hysterical temperament disposes to neuralgia of the spine, joints, and bones.

The exciting causes of neuralgia are of a local and general nature. Among the former, exposure of a nerve to the air, or its compression by some tumor, as an exostosis, or soft growth, is the most common. The most atrocious attacks of this disease are generally witnessed in the branches of the trifacial nerve, in consequence of caries of the teeth, laying open their cavity, and thus allowing the air and other irritating substances to come in contact with the denuded nerve within. Similar effects are often produced by the pressure of a dental exostosis, or by the mere thickening of the periosteum covering the fang of a tooth. Occurrences of a like nature often excite neuralgia in the bones. Sometimes the disease is awakened by the contusion of a nerve, occasioned by a blow, fall, or kick; by the irritation of an old, indurated cicatrice; or by the excitement induced by the presence of a foreign body, as a splinter of wood. In the face, neuralgia may be caused by the lodgment of a piece of dead bone in the nose or antrum. A calculus may produce the disease in the bladder, worms in the bowels, and the larvæ of insects in the frontal sinus. Neuralgia of the pelvic viscera is often induced by the pressure of a displaced uterus upon the surrounding structures.

Exposure to cold while the body is overheated and covered with perspiration is a very common exciting cause of neuralgia. When the predisposition to the disease is very strong, the slightest draught of cold air will often almost instantaneously bring on an attack. Exposure to heat is less injurious, although it is also capable of exciting the disease, especially when the heat is concentrated for any length of time upon one particular locality.

Attacks of neuralgia are sometimes induced by gastro-intestinal irritation, dependent upon a redundancy of acid, indigestible food, worms, impacted feces, or an overloaded state of the bowels. The disease is not uncommon in dysmenorrhœa, in ulceration of the neck of the uterus, in spinal irritation, and in organic lesions of the brain.

A syphilitic taint of the system occasionally gives rise to it. Lancereaux has recorded three cases of sciatica which, having long resisted all treatment, yielded as if by enchantment to the use of mercury and iodide of potassium. Gonorrhœa may act in a similar manner, the attack being characterized by the suddenness of its invasion, the rapidity with which it attains its maximum of intensity, and the shortness of its duration.

Occasionally the cause is seated in the nerve itself, as when it is inflamed, partially ulcerated, or denuded of its natural coverings. After amputation, the stump often becomes affected with neuralgia in consequence of the extremities of some of the nerves being expanded into neuromatous tumors; and similar effects sometimes supervene upon the division of the nerves in cases of wounds, especially lacerated ones.

Finally, the occurrence of neuralgia, as a consequence of malaria, is familiar to every one. In the southern and southwestern States of the Union, where neuralgia of every form and grade is extremely prevalent, the disease, in the great majority of cases, recognizes no other cause. The attacks, under such circumstances, are generally of a distinctly intermittent type, very similar to those of intermittent fever, recurring once every day or every second day, and, after having continued with great severity for several hours, gradually going off, to reappear about the same period on the next day; each paroxysm being, perhaps, ushered in by chilly sensations, and terminating in more or less profuse perspiration.

Symptoms.—The nature of the pain in neuralgia is not always the same. In one case, it is dull, heavy, and aching; in another, acute and extremely violent; in a third, it resembles the pain produced by thrusting needles into the tissues; in a fourth, it is pungent, smarting, or burning; in a fifth, it is sharp and darting, like an electric shock, running through the parts with the rapidity of lightning.

The pain, whatever its character may be, is generally attended with more or less soreness and tenderness of the affected parts, which sometimes pit on pressure, although they are seldom discolored. Finally, the pain may be concentrated, or diffused; that is, it may be strictly localized, or limited to one particular spot, and that, perhaps, a very small one; or it may be extended over the greater portion of a nerve, or even over its entire length.

It is important to bear in mind that the pain often breaks out at a point very remote from the one upon which the impression provoking the attack is made. Thus, supraorbital neuralgia is often produced by disorder of the stomach, or of the stomach and bowels; a carious tooth has been known to give rise to neuralgia of the hip; and spinal irritation not unfrequently occasions neuralgia of the leg, heel, and foot. A very singular

case has been reported where a severe attack of neuralgia of the left forearm could always be instantly excited by touching the meatus of the right ear.

Neuralgia is sometimes associated with rheumatism, and it is to this form of the disease that the term rheumatico-neuralgic is usually applied by nosologists. The combination is most generally met with in persons of an arthritic predisposition, commonly affects the muscles, especially the intercostal and spinal, and is often exceedingly intractable, rendering the patient miserable for life, and at length wearing him out by the constancy of his pains.

Neuralgia often exists simultaneously in different parts of the body, and when it is once fairly established it is easily excited by the most trivial circumstances. Its progress is variable. In many cases it readily yields to treatment, or disappears even spontaneously; on the other hand, it is sometimes a most intractable disease, worrying and fretting the patient, undermining his general health, and disqualifying him for business and enjoyment. In its worst forms the suffering is almost constant; whereas, in the milder, there are not unfrequently long intervals of complete, or nearly complete, exemptions from pain. When the affection is contracted early in life, and proves rebellious, it is seldom entirely got rid of, whatever means may be adopted for its relief.

Pathology.—The pathology of neuralgia is not understood. It has generally been supposed to consist in a mere exaltation of the sensibility of the nervous tissue, but if this were true it would, probably, not be so intractable a disease as it often is. The explanation may, perhaps, hold good in those cases in which the disorder is very transient, or of malarial origin. In general, however, there is some degree of inflammation, either in the nerve-pulp or in the neurilemma, or in both, as is proved by the fact that the parts supplied by the affected nerves are commonly more or less tender, œdematous, and even somewhat discolored; phenomena clearly indicative of an engorged and incited state of the capillary vessels with a tendency to effusion. In other cases, again, it may consist in a mere perversion of the nervous fluid, as when a nerve is compressed by interstitial deposits, or by causes acting upon its periphery, thereby interrupting the current across the seat of the obstruction.

Neuralgia seldom proves fatal. Its course is irregular. It may last for months, years, a lifetime, the patient finally dying of some other disease. The most dangerous form is visceral neuralgia, which sometimes causes death by the constancy and violence of the attendant pains.

Treatment.—The treatment of neuralgia must be deduced, in great degree, from the nature of the exciting cause, which should, therefore, always receive prompt attention, removing it where this is practicable, or modifying it where it is not, so as to render it as harmless and inoperative as possible. In neuralgia of the face, for example, it will often be found that the cause of the trouble is a carious tooth, upon extracting which the pain instantly vanishes. Neuralgia dependent upon the presence of an old, callous cicatrice, can only be successfully relieved by the excision of the offending tissues. Vermifuge medicines are indicated when it is caused by worms; antacids, when it is excited by vitiated secretions of the stomach; purgatives, when it is occasioned by an overloaded state of the bowels. Thus, it will be perceived that no single remedy, or class of remedies, is adapted to all cases; a fact which strongly suggests, in every instance, the importance of a most thorough and critical examination of the state of the part and system, with a view to the institution of a rational therapeutics.

It must not be expected, however, that the disease will always disappear upon the removal of the exciting cause. Generally, indeed, it will, and that very promptly and effectually; but there are cases where it is inclined to linger, with little or no mitigation, for an indefinite period, the affected parts being seemingly unable to recover their natural functions, either because they have become habituated to the morbid action, or because they have experienced some organic change which no medication can reach.

The treatment of neuralgia is general and local, except when the cause is obviously of a purely local character, when general means may usually be dispensed with. Purgatives, a proper regulation of the diet, and antineuralgic remedies, as they are named, constitute the more important constitutional measures; while embrocations, leeches, vesicants, the hypodermic use of morphia, and section of the affected nerves, comprise the more efficient and reliable topical agents.

There are few cases of neuralgia which are not benefited by the use of purgatives; sometimes, indeed, the disease promptly disappears under a few brisk cathartics. Their exhibition is particularly indicated when there is a coated state of the tongue, disorder of the stomach, a vitiated condition of the secretions, headache, pain and aching in the limbs,

or an overloaded condition of the bowels. The best articles are blue mass, colocynth, and jalap, or the compound calomel pill, repeated every other night until there is a decided improvement in the general health. Emetics may often be advantageously exhibited, especially when there is evidence of biliary and gastric derangement. The pain is generally mitigated by their action, and sometimes completely removed, the moment they begin to manifest their specific effect.

The diet must be plain and simple, easy of digestion, and adapted, in regard to its nutritive qualities, to the exigencies of each particular case. The plethoric will be benefited by abstinence; the pale and anemic, by good living. When the general health is much impaired, tonics, as quinine and iron, a generous diet, wine, brandy, porter, and ale, with exercise in the open air, will be of service. Sometimes a sea voyage, or a residence near the sea shore, is salutary.

There are several articles of the materia medica which may be considered as exerting, in some degree, a specific influence over neuralgic affections, and which have hence received the name of antineuralgic remedies. To this class belong quinine, arsenic, strychnia, aconite, and morphia, along with some other anodynes, and the different preparations of iron.

Quinine, the great antiperiodic in intermittent fever, is entitled to the highest rank in the treatment of neuralgia, particularly in that variety in which the paroxysms observe a regular diurnal relapse, with an interval of entire freedom from suffering. It may be administered by itself or in union with an opiate, and a few efficient doses are almost sure to break up the attack promptly and effectually. In my own practice, I seldom give less than ten grains at a dose, repeated every six or eight hours, until the affection is either vanquished, or the specific effects of the medicine are rendered apparent by the aural and cephalic distress. Some practitioners prefer smaller doses, but experience has shown me that they are less trustworthy, and that, at all events, a much longer time elapses before they put a stop to the disease. Quinine is sometimes very beneficial when the affection is not of malarial origin, but, in general, its effects are much less apparent.

In chronic neuralgia, or in acute but obstinate attacks, arsenious acid is generally found to be one of the best remedies, given in doses varying from the eighth to the fifteenth of a grain, three times a day, in union with an anodyne, or anodyne and tonic. There are few cases of the disease, however obstinate, that will not be materially benefited by the use of this article, if administered with proper judgment and perseverance. The acid is far preferable, in every respect, as an antiperiodic, to Fowler's solution, as it is much less liable to cause nausea and anasarca.

With the value of strychnia, as an antineuralgic, every practitioner is familiar. I have used it, as such, for many years, and its effects have rarely entirely disappointed my expectations. The dose recommended in the books is much too large. I rarely give more than the sixteenth or twentieth of a grain, thrice in the twenty-four hours. Extract of nux vomica is also employed for the same purpose, but is seldom productive of any decided benefit.

In trigeminal neuralgia the most reliable remedies are croton chloral, gelsemium, and Duquesnel's crystallized aconitia. The first of these articles may be exhibited in one grain doses every hour. The gelsemium is administered in the form of tincture in doses of twenty drops every half hour until three doses have been taken. Aconitia is contra-indicated in disease of the heart. In ordinary cases the one hundred and fortieth of a grain, dissolved in alcohol, glycerine, and water, is repeated every eight hours.

In some cases relief is more readily obtained from the exhibition of chloride of ammonium than from any other remedy. It is particularly serviceable in neuralgia of the face and head, especially in that form of the disease known under the name of hemicrania; but it may also be very advantageously employed in neuralgia of the viscera, spine, chest, and extremities. The dose should generally be large, as from twenty to thirty grains, repeated three or four times in the twenty-four hours.

The use of morphia is absolutely indispensable in the treatment of neuralgic complaints, not so much as a curative agent, as for the purpose of controlling the excessive pain and inducing sleep. There are cases, however, which are radically cured by the persevering exhibition of this remedy, but then it is generally necessary to give it in large and sustained doses. Protracted narcotism has occasionally vanquished the disease after all other means have failed to afford even temporary relief. Several examples of this kind have fallen under my own immediate observation, and others have been mentioned to me by professional friends. For ordinary purposes the quantity need not exceed a fourth

or third of a grain, and, in chronic or subacute cases, I rarely give more than the tenth, twelfth, or fifteenth of a grain, repeated thrice a day.

For many years past I have been in the habit of employing, with very happy effects, in a great variety of cases of neuralgia, a combination of some or all of the above articles, giving them in pill form three or four times in the twenty-four hours. The subjoined will serve as a type of such a formula.[1] It need hardly be added that the effects of the prescription should be carefully watched, as several of the articles are of a potent and even a poisonous character. If the system be anemic, two grains of the sulphate of iron or of the valerianate of that salt may be incorporated with each pill. Carbonate of iron I never use, as it has always disappointed my expectations, even when administered in large doses and for a long time, and my experience, in this respect, is, I believe, fully corroborated by the results of the observations of other practitioners. When the attack depends upon the presence of a redundancy of vitiated gastric acid, the solution of valerianate of ammonium will be found a highly efficient remedy, administered in the dose of a drachm every two or three hours until relief is afforded. Iodide of potassium has been much lauded as an antineuralgic; but, although I have used it in many cases, I cannot recall to my mind a solitary one wherein it seemed to be really of any material service. If it ever does any good in this disease, it is when it partakes of a syphilitic nature.

When the attack is of a rheumatico-neuralgic type, colchicum will generally act more kindly and promptly than any other article. My invariable plan, however, is to give it in union with a full dose of morphia, as half a grain of the salt with one drachm of the wine of colchicum, every night at bedtime, which will be found to be a much better practice than administering these substances in smaller and more frequently repeated quantities.

The topical remedies which particularly claim attention on account of their real or imputed virtues are counterirritants, leeches, morphia, electricity, and the steam of hot water, either simple or medicated.

The only counterirritants that, in my judgment, are at all admissible, in the treatment of this disease, are blisters, ammonia, and iodine. Setons and issues are out of the question, except in deep-seated, obstinate visceral neuralgia, when the latter occasionally prove beneficial, especially if made with the hot iron, directly over the seat of the pain, so as to afford a free and protracted discharge. The moxa, formerly so much used, has of late years fallen into disrepute. Blisters are particularly valuable in inflammatory neuralgia; they should be retained until the epidermis is well raised, and they are the more desirable because the raw surface thus made may be advantageously employed for the topical application of morphia. Temporary relief, but nothing more, occasionally follows the use of ammonia in the form of liniment, or of Granville's lotion, frictions with ointment of veratria, and painting the parts with tincture of iodine. Leeching is sometimes useful, by relieving congestion, and thus removing one cause of compression of the nerve-pulp, the operation being performed as nearly as possible to the seat of the disease.

Professor Hammond speaks highly of the primary galvanic current, furnished by fifteen or twenty Smee's cells. The positive pole should be placed over the seat of pain, and the application should be continued for half an hour every day for several weeks.

Hot applications are generally beneficial in putting a prompt stop to the severity of the pain, especially if they are medicated with laudanum, or some other anodyne preparation. They may be used in the form of cloths wrung out of hot water, and covered with oiled silk, to prevent evaporation; or, in that of steam conveyed directly to the part by means of a tube connected with a tea-kettle placed over a spirit lamp near the bed.

Of all the local remedies for neuralgia, the most reliable, so far as my experience goes, at all events so far as transient relief is concerned, is the hypodermic injection of morphia, as nearly as possible to the seat of the pain. A good average quantity of the salt is from one-third to half a grain, dissolved in one drachm of tepid water, and introduced with a good syringe. In very urgent cases the quantity may be increased, and its value greatly enhanced by the addition of the fiftieth of a grain of sulphate of atrophia.

Another remedy of great value, strongly recommended by Professor C. G. Comegys, of Cincinnati, is the hypodermic injection of twenty to thirty drops of sulphuric ether,

[1] ℞ Quiniæ sulph. ʒj ;
    Morphiæ sulph. gr. jss ;
    Strychniæ sulph. gr. ij ;
    Acid. arseniosi gr. ij ;
    Ext. aconiti gr. xv.
Mix, and make xxx pills ; one to be given three or four times a day.

thrown into the affected tissues twice a day. The remedy has been found especially beneficial in sciatica.

Veratria ointment, prepared with from forty to sixty grains of the alkaloid to the ounce of simple cerate, is also an excellent remedy, from which I have frequently derived the very happiest effects. A small quantity—a portion about the size of a cherry—is applied two, three, or four times a day to the seat of the disease, with the bare fingers, the friction being continued until it produces a strong tingling, smarting, or burning sensation, when the surface is covered with wadding or soft flannel. In the milder forms of the disease veratria occasionally acts as a curative agent, although, in general, it is simply a palliative.

Mere division of a nerve for the cure of neuralgia is a perfectly useless procedure. Excision, on the contrary, is often followed by the happiest results, especially when performed for neuralgia of the face, caused by disease of the second and third branches of the fifth pair. Quite a number of very bold and novel operations have been performed within the last thirty years upon these nerves, especially the superior maxillary, by American surgeons, Professor Carnochan having led the way. The methods by which the object is accomplished will be fully described in their proper place. Sections of the larger nerves, as, for example, the sciatic, median, ulnar, and musculo-spiral, have sometimes been removed, and, indeed, even the brachial plexus itself, as in the examples recorded by Sands and Seguin, Maury, and others, although rarely with any permanent benefit. Occasionally, however, there is an exception to this rule, as in a case of neuralgia, consequent upon a gunshot wound of the median nerve, treated by Dr. J. L. Stewart, of Erie. The injury had been inflicted ten years previously, and the pain, which had been of the most atrocious character, requiring immense doses of morphia for its relief, was speedily and permanently cured by the excision of three inches of the affected nerve, without any unpleasant consequences in the parts naturally supplied by it.

Nerve-stretching, for the relief of neuralgia, has lately been attracting much attention, and from the success, partial or complete, which has attended it, is worthy of more extended trial. The operation consists, first, in exposing the affected nerve by a free incision ; secondly, in hooking it up, if large, with the index finger, or, if small, with an aneurism needle ; thirdly, in stretching it more or less thoroughly ; and, lastly, in replacing it in its natural locality, the wound being closed and treated in the usual manner. In a nerve like the sciatic, the patient's limb, after the stretching is effected, is lifted from the table by the nerve. The success of the operation is complete when the neuralgia is of traumatic origin.

SECT. V.—PARALYTIC AFFECTIONS.

1. WASTING PALSY.

A peculiar affection of the muscles, consisting essentially in atrophy and fatty degeneration of their fibres, has been described under the name of progressive muscular atrophy, or wasting palsy, from the fact that wasting and loss of power of these structures are its most prominent features. The disease, first accurately delineated by Cruveilhier, has been studied with great care by several European observers, especially Aran, Duchenne, Wachsmuth, Eisenmann, Meryon, Jackson, and Roberts.

Wasting palsy presents itself under two varieties of form, the partial and general ; the first, as the name implies, being limited to particular muscles, or sets of muscles ; whereas the other involves nearly all the voluntary muscles, those of mastication and those of the eyeball, including the elevator of the upper lid, being the only ones exempt from its ravages. The involuntary muscles, however, remain altogether intact, even in the worst cases and in the most advanced stages of the disease. Hence, the reason why the general health is usually so perfect amidst this wreck of the active agents of locomotion.

Of the causes of atrophy and palsy of the muscles nothing is positively known. If their development has occasionally been clearly traced to the effects of cold, to rheumatism, or to excessive and long-continued fatigue, such as attends various mechanical pursuits, it is equally certain that, in the great majority of instances, no plausible reason can be assigned for their occurrence. Now and then the lesion appears to have a syphilitic or strumous origin.

The time of life at which the disease occurs is variable ; it has been noticed in young children, and, on the other hand, occasionally in old subjects ; but the most obnoxious period would seem to be between twenty-five and thirty-five. Thus, in eighty-eight cases,

analyzed by Dr. Roberts, in 1858, the average period was thirty years and six months. General atrophy is not limited to any particular age, but attacks indiscriminately children, adults, and old persons; whereas the partial form rarely shows itself before puberty and after fifty. Both sexes are liable to it, but males suffer much oftener than females. The lesion has occasionally been observed in several members of the same family, and also in the offspring of persons who had themselves been its victims, thus exhibiting a kind of hereditary tendency.

The muscles that are most liable to suffer in this affection are those of the extremities, especially the upper. The wasting generally begins at one particular part of a limb, from which it gradually extends to another; but, now and then, cases are met with in which it attacks simultaneously several points.

It has been noticed that there is usually a tendency in certain muscles to suffer together, as if they were united by a very close fellow-feeling; thus, it has been found that whenever wasting palsy occurs in the muscles of the hand, it is extremely liable to affect those of the forearm also; a similar disposition has been remarked in reference to the muscles of the shoulder and those of the arm. Moreover, experience has shown that when one limb is invaded, its fellow is very apt to share the same fate.

The most important *symptoms* of this disease are wasting of the muscles and loss of contractile power, generally coming on in a slow, gradual, and stealthy manner. In the great majority of cases, indeed, the person is unconscious of the mischief that is taking place, until attention is accidentally directed to the subject by a failure of the power of one of his limbs, especially the hand and foot. "The tailor discovers," says Dr. Roberts, "that he cannot hold his needle; the shoemaker wonders he cannot thrust his awl; the mason finds his hammer, formerly a plaything in his hand, now too heavy for his utmost strength; the gentleman feels an awkwardness in handling his pen, in pulling out his pocket handkerchief, or in putting on his hat. One man discovered his ailment in thrusting on a horse's collar; another, a sportsman, in bringing the fowling-piece to his shoulder." The wasting, at first very slight, progressively increases until the affected muscles are rendered perfectly soft and flaccid, and their substance is so much wasted that they are hardly one-fifth of the natural bulk; they are, in fact, completely withered, as if they had been starved, and deprived of all nervous influence. The loss of power is generally in proportion to the wasted condition of the muscles, proceeding gradually from bad to worse, until the parts are entirely disabled and useless, no effort of the will being capable of exciting the slightest action.

Besides the above more prominent symptoms, there are others of a minor and subsidiary character. These are fibrillary tremors, cramps and twitches, pain, and a remarkable susceptibility to cold.

Fibrillary tremors, or convulsive twitchings, are very common, especially in the earlier stages of the complaint; they are dependent upon the irregular contraction of individual muscular fibres, and are, consequently, always absent when the disease has reached its full development. They generally occur without the consciousness of the patient, and may usually be readily excited by exposure of the affected parts to a current of cold air or water. Cramps are also very frequent; they come on at various intervals, and often constitute a source of actual suffering, especially when they are accompanied with pain, which is present in about one-fourth of the cases. The pain may be slight and wandering, severe and fixed, or sharp and neuralgic, shooting about in different directions with the rapidity of lightning. In some instances it occurs in different parts of the muscular system, more or less remote from the seat of the disease, and is then apparently of a rheumatic character. Wasting palsy causes a remarkable sensibility to cold, especially to a cold, humid atmosphere, so that the patient requires an uncommon amount of clothing to keep himself warm and comfortable. Finally, the galvanic excitability of the muscles regularly diminishes with their decay, although it is not wholly annihilated until they have completely lost their primitive structure.

It is remarkable that, amidst all this wear and ruin of the muscular system, the general health should uniformly remain unimpaired, even in the worst forms of the disease. The appetite and sleep are excellent; digestion is well performed; the bowels move with their accustomed regularity; and the functions of the kidneys are perfectly normal. The intellect is clear to the last, and the senses retain their wonted vigor. The only trouble which the patient occasionally experiences is difficulty of respiration, from involvement of the diaphragm.

The progress of the disease is generally slow, the muscles steadily decaying, until they are at length completely changed in their character; for months and even years they

retain some contractile power, and are even susceptible of restoration. General atrophy is always a gradual affection; it seemingly begins in the partial form of the lesion, and is probably merely an aggravated state of it. When the disease has reached this crisis, the patient may be unable to use any of the muscles, excepting, as already mentioned, those of mastication and those of the eye.

The appearances revealed on *dissection* are characteristic. The muscles, as might be expected, are wasted in various degrees; some slightly, others very much, and others, again, so completely as to be hardly recognizable, consisting merely of fibrous vestiges, with no distinct trace of the normal structure. The color of those that still remain is much faded, being pale red, rose, buff, or yellowish, according to the extent of the atrophy; and in all, or nearly all, there are well-marked evidences of granular and fatty degeneration, the former generally preceding the latter, although they occasionally exist independently of each other. Sometimes these changes are confined to one particular part of the muscle, as one-half or two-thirds of its belly, while the other portion retains its natural hue and consistence. Under the microscope, the striped primitive fibres are observed to have vanished, their place being supplied by granular matter and oil globules, and their investing tunic broken down and disintegrated.

The nervous system has been closely scrutinized during the past few years in many of the reported cases of wasting palsy, and it appears to be well established that the affection depends upon chronic inflammation of the gray substance of the anterior tract of the spinal cord, with secondary atrophy of the anterior roots of the nerves derived from the seat of the lesion.

The prognosis is generally unfavorable; the partial form is occasionally recovered from, the complete never. In the latter case death, which does not occur under several years, is usually preceded by great difficulty of respiration, in a paroxysm of which the patient suddenly expires. In partial atrophy, the disabled muscles, after having struggled on for many months, perhaps neither sensibly advancing nor receding, gradually awake from their torpor, and ultimately regain some contractile power, although never their full vigor.

In the *treatment* of wasting palsy, any disorder of the general health should promptly be corrected. If the lesion can be clearly traced to a syphilitic or strumous taint of the system, as is occasionally the case, the proper treatment will be iodide of potassium with bichloride of mercury; or, when a tonic effect is required, potassium with iodide of iron. Gentle purgatives will be useful when there is constipation with derangement of the secretions. The diet must be plain, simple, and unirritant.

The best local remedy, in the early stage of the disease, is a blister sufficiently large to cover the whole of the affected muscles, and retained long enough to produce thorough vesication. If decided improvement do not follow in a week or ten days, the application should be repeated. The hot douche, immediately followed by the cold, will also be found serviceable, but to prove efficacious it should be aided by frictions with some stimulating embrocation, as spirit of camphor, or alcohol and ammonia. Veratria ointment is a powerful excitant, and has frequently proved highly efficacious in my hands. The cold douche alone is objectionable, on account of its depressing tendencies. Massage will be found useful, and should be practised several times a day. Galvanism has been greatly extolled by Duchenne, Meyer, Gros, and others, and there can be no doubt that it has occasionally rendered good service. The constant primary current should be passed rapidly over the disabled muscles, taking care to return to each several times during the same sitting; it should be strong in proportion to the obtuseness of the parts, but be gradually diminished as the sensibility augments, otherwise overstimulation may occur, and thus do harm instead of good. The application may be repeated, at first, every twenty-four hours, and afterwards twice a day.

The treatment, whatever it may be, should be combined with gentle exercise of the affected parts, to recall them, as it were, to a sense of their duty. They should, in fact, be reëducated by a system of careful training, steadily and perseveringly continued for many months, if not for several years. Conducted in this way, great confidence may be entertained of ultimate benefit.

2. INFANTILE PALSY.

There is a variety of paralysis which, occurring in young children, generally during the first dentition, is, in point of obstinacy and incurableness, if possible, still more deplorable than the one above described. It may be called infantile palsy. Its attacks are usually sudden and unaccountable. The child goes to bed in the evening, perhaps to all

appearances perfectly well; during the night, however, he becomes feverish and restless, and in the morning, on attempting to walk, he is unable to stand or use his legs. The limbs soon lose their round, plump appearance, the muscles are rendered soft and flaccid, the feet trail the floor, and the surface feels cold and numb, although sensibility is seldom entirely destroyed in any case, however extensive.

The seizure is much more common in the lower extremities than in the upper; very often it is confined to one thigh and one leg, or to one thigh or one leg alone; but occasionally both limbs, or even all four, are involved, the child being perfectly helpless, and in the most pitiable condition. The paralysis is generally complete, but cases occur in which the little sufferer is still able to use certain muscles, although not with anything at all like their natural freedom and strength. When the upper extremity is attacked, the deltoid muscle is very liable to be affected, becoming remarkably soft and wasted, so that the patient finds it impossible to elevate the arm or lift the smallest weight.

The cause of this variety of palsy is not always very evident. In general, however, it depends upon inflammation of the anterior horns of gray matter of the spinal cord, followed by atrophy and disappearance of the nerve cells. As the result of these central changes, the muscles usually undergo fatty degeneration, and the development of the bones is arrested.

The general health is seldom impaired in infantile palsy; the mind acts with its accustomed vigor, and all the bodily functions are well executed. As the child advances in years, all the limbs, excepting the disabled ones, increase in size and strength, but the latter remain stationary, or dwindle away still further, and thus form a striking contrast with the sound. In cases of long standing, there is often fatty degeneration of the muscles, although occasionally the paralysis continues for years without any change of this kind.

The prognosis is variable, although generally unfavorable, especially if the disease is neglected or improperly managed in the first instance. Little, if any, benefit will be likely to accrue from any mode of treatment, however judiciously or perseveringly conducted, after the lapse of six, eight, or ten months. The difficulty of effecting restoration is much increased when there is fatty degeneration of the muscles; a circumstance which may readily be ascertained by extracting, by means of a small trocar, devised by Duchenne, and delineated at page 433, a minute portion of the suspected structure, and subjecting it to a microscopical examination. The absence of electric contractility is also an unfavorable sign. If the induced current is powerless, the cure will be difficult, while it will be impossible if the muscles do not respond to the galvanic current.

The *treatment* of infantile palsy must mainly be directed, in the first instance, to the spinal cord, upon the disorder of which the disease essentially depends. For this purpose, leeching, cupping, rubefacients, and blistering, with absolute rest in the recumbent posture, should promptly be employed, soon followed, if the case is likely to be obstinate, by a free issue with the actual cautery, applied as nearly as possible to the seat of the lesion. The discharge must not be too abundant, or protracted, otherwise it may occasion undue debility. Frictions with veratria ointment along the whole length of the spine and of the sciatic nerve, repeated twice in the twenty-four hours, have been of great service in my hands. An early resort to mercury is very important. The best form is calomel, in doses of the fourth of a grain, night and morning, continued, with an occasional brief intermission, for several successive months. The fluid extract of ergot is also indicated in the early stage of the disease, or before atrophy of the muscles has set in. In some instances, especially in the more chronic forms of the disease, I have derived signal benefit from a combination of iodide of potassium and bichloride of mercury. As recovery advances, strychnia may be of use, but I have never seen any good from its exhibition in the earlier stages of the complaint. When the child is feeble and anemic, iron and quinine, milk punch, and fresh air must be conjoined with other means to invigorate the system. The bowels and secretions must receive proper attention.

The affected extremities must frequently be rubbed, shampooed, switched, and placed upon a course of careful training, as advised under the head of wasting palsy. Immersion of the limbs in water as hot as it can be borne, for twenty to thirty minutes, twice in the twenty-four hours, will be found to exert a highly beneficial influence in restoring temperature. The early and long-continued application of electricity is often followed by great improvement, if not positive relief, and should never be neglected. The alternate use of faradization and galvanization will probably insure the best results.

The contraction of the tendons, consequent upon this variety of palsy, must be rectified by appropriate apparatus, aided, in obstinate cases, by tenotomy.

3. PSEUDO-HYPERTROPHIC MUSCULAR PARALYSIS.

A distinct form of paralysis, first observed and accurately described by Duchenne, in 1858, and consisting essentially in hypertrophy and sclerosis of the interfibrillar muscular connective tissue, is occasionally met with in infancy and early childhood, and is known as the pseudo-hypertrophic or myo-sclerosic paralysis, or progressive muscular sclerosis.

The disease generally begins before the tenth year, mostly in boys, without any assignable cause, but now and then after convulsions. As soon as the child begins to walk, weakness of the lower limbs, with inability to stand or move without stumbling, is noticed, and is soon followed by a peculiar, stiff, waddling gait, the limbs being separated from each other, and the body rolling from side to side. The spine is curved forwards in the dorso-lumbar region, the belly being prominent and the shoulders thrown backwards, thereby producing the characteristic attitude of the affection, which is due to debility of the extensor muscles of the trunk, and disappears during recumbency. In the course of a few weeks or months the muscles of the calves become enormously hypertrophied, and, while those of the thighs, buttocks, and loins are soon involved, the muscles of the upper extremities are less commonly affected. With the advance of these changes, the paralysis is more strongly marked, the gait is more uncertain and tottering, and the child becomes finally utterly helpless. The circulation of the affected limbs is lessened, the skin being cold and mottled, but its sensibility is not impaired, and reflex and electro-muscular contractility are also decidedly diminished. Double equinus, or equino-varus, is not of infrequent occurrence.

The progress of muscular sclerosis is generally slow, the disease rarely terminating before five or six years from its commencement. As the paralysis advances, emaciation and impairment of the intellectual powers set in, and death results either from pulmonary complications induced by weakness of the respiratory muscles, or from some intercurrent disease.

Of the intimate nature of this variety of palsy nothing very definite is known, but it is probable that the anterior tract of gray matter of the cord is the seat of the morbid changes. The muscular fibres themselves are atrophied and non-striated, but otherwise unchanged; while the interstitial connective tissue is greatly hypertrophied, and, in the later stages of the affection, replaced by fat cells.

The treatment of this affection does not differ from that of ordinary infantile palsy, but all measures generally prove unavailing. Duchenne obtained one cure in thirteen cases by the induced current and shampooing, but the gastrocnemial muscles were only slightly enlarged, and Benedikt noticed marked improvement in three cases from the constant current to the lower cervical sympathetic ganglion and the lumbar region.

4. PARTIAL PALSY.

Besides the above forms of palsy there are some others, to which the term partial, transient, or anomalous may be applied, such, for instance, as loss of motion of one side of the face, one eyelid, one side of the tongue, or of the hand, forearm, arm, or shoulder, or even of the entire superior extremity. The subjoined facts will serve as illustrations of its character.

Pressure upon the nerves is liable to be followed by interruption of their functions, at one time temporary, at another permanent. A case recently came under my observation in which a man, thirty-five years of age, suffered from partial palsy of the forearm and hand from having rested for two hours with his head upon the limb as he lay asleep upon the floor.

In another case, under my notice several years ago, temporary paralysis of the left upper extremity was produced by the arm, thrown across the top of a chair, being compressed by the head while the man was asleep. Pressure of the head of a crutch upon the axillary plexus of nerves occasionally leads to weakness, numbness, and pricking pain in the arm, hand, and fingers. Recently a youth of fifteen was under my charge on account of paralysis of the arm, consequent upon a fall on the shoulder from a railway car, two months previously. The limb was instantly deprived of motion and sensation, and so continued up to the time of his visit. The head of the humerus had been thrown slightly forwards against the coracoid process, but it exerted no perceptible pressure upon the brachial plexus of nerves.

Paralysis of one side of the face from injury of the portio dura is not infrequent ; more generally the affection is caused by suppression of the cutaneous perspiration, from exposure to cold and wet ; and an instance is occasionally met with in which it is produced by disease of the petrous portion of the temporal bone. The subjoined case affords a good illustration of a very common form of facial palsy. A blacksmith, eighteen years of age, of temperate habits, came under my care on account of paralysis of the left side of the face. The attack had occurred suddenly three days previously, without any apparent cause, soon after eating a moderately hearty dinner. He had been subject to frequent and severe paroxysms of headache, preceded by dizziness and vertigo. On the morning, however, on which he was seized with palsy he had felt uncommonly well. His appetite and sleep had always been good, and his bowels regular. The palsy was characterized by loss of motion in the muscles of the left side of the face, and by inability to close the left eyelids, accompanied with a want of sensibility of the skin. The tongue, when protruded, inclined to the right side, and was deprived of feeling and taste, a lump of sugar, held in the mouth, making no impression on the affected side of the organ. The general health was excellent.

In the treatment of these paralytic affections, special attention must be directed to the improvement of the general health, which is often seriously impaired, by the use of laxatives, alteratives, and a properly regulated diet. In obstinate cases, a mild mercurial course is sometimes serviceable, especially when the lesion is dependent upon organic disease of the brain, or of the cerebro-spinal axis. The principal local remedies are leeches, blisters, stimulating embrocations, veratria ointment, and the hot and cold douches, followed by dry friction. Occasionally electricity proves beneficial.

CHAPTER IV.

DISEASES OF THE LYMPHATIC VESSELS AND GLANDS.

The pathologist can certainly not boast of his knowledge of the diseases of the lymphatic vessels ; he knows, it is true, that they are liable to inflammation, but of the manner in which it is produced, and of the effects to which it gives rise, he is, in great measure, ignorant. That these vessels play an important part in various affections is extremely probable ; but such are their excessive tenuity and the great delicacy of their structure that no one has yet been able to point out the character and amount of their participation. It has been supposed that at least one form of cutaneous disease, namely, erysipelas, essentially consists in inflammation of the absorbents, and it must be confessed that the opinion, although insusceptible of demonstration, is highly plausible. Much light has, however, been thrown upon the injuries and diseases of the absorbent system, by the writings of Dr. S. C. Busey, of Washington, which may be profitably consulted by the reader.

SECT. I.—LYMPHATIC VESSELS.

Inflammation of these vessels, technically called angeioleucitis or lymphangitis, is most advantageously studied in connection with external injuries, particularly punctured and poisoned wounds, of which it is by no means an infrequent consequence. Doubtless, the disease is sometimes idiopathic, or dependent upon internal causes, such as give rise to erysipelas and other bad forms of inflammation in the cutaneous and other tissues. In the case of a gentleman recently under my observation, the disease, which involved both upper extremities, was evidently due to disorder of the digestive apparatus, occasioned by malaria. Three similar attacks had been experienced before, each coming on during the latter part of August, and promptly yielding to quinine. Numerous superficial vessels were involved in each of the attacks. When arising as a consequence of an abrasion, or the prick of a needle, as in sewing up a dead body, the affected vessels can be easily

traced, as they pass beneath the skin, as small, reddish cords, tense. nodulated, and painful to the touch, accompanying the principal veins, and extending as far as the nearest glands, in which they appear to terminate. The number of these reddish lines is variable; sometimes there are only two or three, while at other times there are as many as six, ten, or a dozen, forming a kind of band, from half an inch to an inch in width. Whenever the number is considerable, there is always a good deal of concomitant swelling; and the parts, feeling stiff, sore, and tender, readily pit on pressure, owing to the effusion of sero-plastic matter. In the more severe attacks of angeioleucitis, as those consequent upon inoculation with putrid or poisonous matter, the tumefaction soon becomes general, spreading rapidly over the whole limb, and the discoloration, losing its striated appearance, so characteristic of the disease in its earlier stages, also assumes a diffused disposition. Arrived at this point, it is usually impossible to distinguish this affection from ordinary erysipelas, so closely do the two lesions resemble each other.

Occasionally the inflammation seems to take its rise in the deeper layers of vessels, and then the discoloration is generally preceded by considerable induration of the subcutaneous connective tissue, giving the part a kind of brawny sensation; by and by, however, red streaks appear in the skin, and then the disease follows very much the same course as when it begins in the superficial vessels.

However originating, the affection nearly always involves the neighboring lymphatic glands, causing them to enlarge, and to become tender, red, and painful. In some of the worst forms of angeioleucitis, the glands manifest signs of being diseased before the absorbents themselves are apparently implicated. Such an occurrence, although uncommon, is occasionally met with in inflammation of these vessels consequent upon dissection wounds.

Angeioleucitis no doubt sometimes passes into suppuration, and, perhaps, even into gangrene; but of these occurrences, as pure, uncomplicated affections, our knowledge is too imperfect to justify any positive opinion.

The symptoms ushering in an attack of angeioleucitis are usually such as are denotive of constitutional depression, following pretty closely upon the injury sustained by the affected vessels. The patient, after having felt indisposed for some hours, seldom more than from twelve to twenty-four, is seized with chilly sensations, accompanied with flushes of heat, a disposition to yawn, headache, pain in different parts of the body, and a dry and contracted state of the skin. Sometimes the attack is announced by violent rigors, rapidly succeeded by high fever and delirium. If the local affection is at all severe, the symptoms soon assume a typhoid character, the pulse becoming weak and frequent, the surface hot and dry, and the tongue covered with a brownish fur. The local distress, meanwhile, increasing, abscesses form in different portions of the limb, the matter being of a foul, unhealthy character, and disposed to spread extensively among the surrounding-structures, in the same manner as in erysipelas and other bad forms of inflammation.

Angeioleucitis may be confounded with other diseases, particularly erysipelas and phlebitis, and the distinction is by no means always so easy as might at first sight appear. In fact, it can only be made out satisfactorily in the earlier stages of the complaint, the principal source of diagnosis being the red, striated appearance of the affected surface, reaching from the seat of the injury up to the nearest lymphatic glands. In phlebitis, the discoloration is also linear, but the cords are much larger, firmer, more knotty, and more deeply seated; they are also less numerous, and there is not nearly so much involvement of the lymphatic glands. In erysipelas, the inflammation usually begins as a circumscribed affection, with diffuse, uniform redness, not striated, as in angeioleucitis, or in phlebitis.

In the *treatment* of this disease, the same general principles are to be observed as in erysipelas and phlebitis, to which it bears so close a resemblance. The exciting cause being removed, such local and general means are to be employed as may seem to be best adapted to the exigencies of each particular case. Bearing in mind that, if the disease is at all severe, the symptoms will be likely soon to assume a typhoid character, the surgeon will take care not to deplete much, especially with the lancet and purgatives, lest he be instrumental in inducing fatal exhaustion, of which the danger may be already sufficiently great in consequence of the progress of the morbid action. Leeches may be applied along the course of the affected vessels, but not directly over them, if the disease is in its earlier stages, and the patient is robust and in the prime of life. They should be employed in considerable numbers, and be succeeded by warm fomentation, the whole limb being

enveloped in flannel cloths wrung out of a strong solution of acetate of lead and opium, and kept constantly wet. The application of iodine is sometimes advantageous; and good effects occasionally arise from thorough vesication, the blister being stretched along the course of the affected vessels. If matter form, or great tension and throbbing exist, suitable incisions must be made.

The constitutional treatment must be regulated by the character of the general symptoms. Purgatives, to clear out the bowels and correct the secretions; iron, or iron and quinine, to improve the tone of the system and the state of the blood; and anodynes, to allay pain and induce sleep, with a properly regulated diet, will constitute the most reliable and efficient means. If marked debility arise, brandy, wine, or porter, with nutritious broths, will be required. When the disease proves obstinate, or becomes chronic, a mild mercurial course may be beneficial.

Varicose enlargement of the lymphatic vessels, or lymphangiectasis, has occasionally been noticed, chiefly among the inhabitants of warm countries. It is most common in the vessels of the scrotum and lower extremity, in union with elephantiasis. The enlargement is sometimes so great and so well defined as to give rise to distinct swellings, which have been described by Virchow and other pathologists, under the name of lymphangioma. In a case mentioned by Carswell, in a young man, twenty-six years of age, a tumor nearly as large as an orange existed in each groin, for which he had worn a double truss from his boyhood, under the supposition that he had hernia. On dissection, however, each tumor was found to consist of enormously dilated absorbent vessels connected with the inguinal glands. When cut into, instead of presenting a solid, compact structure, it had the appearance of a coarse sponge, most of the vessels being from one to three lines in diameter. The same phenomenon was witnessed, only in a more striking degree, in the lymphatics of the pelvic and lumbar regions. The spongy and elastic character of such a swelling ought to prevent any serious error of diagnosis. Hardly any treatment would be necessary in such a case. Excision might prove dangerous, and should not be practised without due deliberation. Bean has reported three cases in which he effected a cure by establishing adhesive inflammation by means of the seton.

In *wounds* of these vessels there is occasionally a veritable *lymphorrhœa*, or a discharge of thin, pale, whitish fluid, standing like drops of sweat upon the affected surface. The exudation has been known to continue for a considerable length of time, and to interfere perplexingly with the healing process. Vidal and Lebert have each described a case in which small, transparent vesicles, filled with lactescent fluid, formed upon the thigh and scrotum. In the case detailed by the latter, the vesicles, after having attained a certain bulk, broke, and discharged their contents, which, on analysis, were found to contain sugar of milk and minute clots. The patient, aged twenty-one years, was affected with hypertrophy of the scrotum.

In the case of a boy, nineteen years of age, affected with elephantiasis of the lower extremity, Dr. J. C. Morris, of the Episcopal Hospital of this city, observed, two weeks after his admission, several vesicles on the thigh, which soon gave exit to lymph, which flowed at the rate of nearly a pint in twelve hours. This continued for five days, when it ceased, apparently in consequence of an attack of erysipelas. In a case of Desjardins eleven pounds escaped in the course of forty-eight hours. At the clinic of the University of Padua, in the summer of 1868, Professor Vanzetti was kind enough to show me a man who had suffered in this way for five years in the left side of an hypertrophied scrotum, large quantities of fluid being discharged every few days.

A wound with such a discharge may, if it heal slowly, at length degenerate into a troublesome *fistule*, difficult to cure, and the seat of a constant exudation of milky fluid, mixed with pus. A similiar accident occasionally follows upon an abscess situated in the course of a large lymphatic trunk. The remedies most likely to afford relief in such cases are systematic compression and the application of the solid nitrate of silver. If these fail, recourse should be had to the knife, Vienna paste, or the actual cautery.

A congenital lymph fistule is sometimes met with, especially in front of the neck. It has generally a very small, almost imperceptible, orifice, and is the seat of a transparent, limpid discharge, possessing all the properties of ordinary lymph. The discharge usually occurs in drops, and may, with occasional intermissions, continue for years. The treatment is similar to that of the accidental lymph fistule.

SECT. II.—LYMPHATIC GLANDS.

The lymphatic glands are liable to inflammation, chronic enlargement or hypertrophy, lymphoma, sarcoma, tubercle, and earthy degeneration.

Inflammation of these bodies, technically called adenitis, may show itself either as an acute or a chronic affection, and is of such remarkable frequency as to demand special consideration. In whatever form it occurs, it is most common in young children of a strumous predisposition, and is generally brought on by attacks of cold, or by some local irritation implicating the afferent lymphatic vessels. The disease, moreover, may be common or specific, of the latter of which illustrations are afforded in syphilitic bubo, in the bubo of plague, and in the swelling of the lymphatic glands of the axilla consequent upon dissection wounds and malignant pustule.

1. *Acute adenitis* is most common in the glands of the neck, jaw, and supraclavicular region ; it is also occasionally met with in those of the groin and axilla. The disease may be limited to one of these bodies, or, as is more generally the case, affect a considerable number of them ; beginning as a hard, painful knot, exquisitely tender to the touch, and rapidly augmenting in bulk, until, in some instances, it attains the volume of an almond or a pullet's egg. The increase in the size of the tumor is sometimes exceedingly rapid, as is often seen in adenitis of the neck from exposure to cold, where a body of this kind, scarcely perceptible in the natural state, may, in the course of a few hours, acquire the size of a filbert, or a small marble. As the disease advances, the swelling extends to the adjacent connective tissue, the skin becomes red and inflamed, and the parts pit on pressure. The discoloration is not unfrequently of an erysipelatous character. When the inflammation is fully developed, the local distress is usually very severe, and the constitution actively sympathizes with the suffering textures, the patient being feverish, deprived of appetite and sleep, and affected with constipation.

Dissection shows the affected glands to be of a deep reddish or brownish color, infiltrated with sero-plastic fluid, softened, lacerable, or easily crushed with the finger ; the connective tissue around is also abnormally vascular and infiltrated, and, in many cases, it seems to be the principal seat of the morbid action.

Adenitis may end in delitescence or resolution, pass into suppuration or assume a chronic character. The occurrence of gangrene is very uncommon.

The disease sometimes vanishes in a few hours, either spontaneously, or under mild treatment. Enlarged and inflamed glands of the neck, and at the angle of the jaw, often rapidly disappear under frictions with ammoniated liniment, conjoined with the use of hot drinks and immersion of the feet in hot water. When the inflammation is more severe, an active purgative will be necessary, followed by a gentle diaphoretic, as one-fourth of a grain of morphia with one-half that quantity of tartar emetic. The diet must be light, and the part and system must be kept perfectly at rest. If the morbid action threaten to prove troublesome, or to pass into suppuration, leeches and medicated fomentations must be employed. In many cases, dilute tincture of iodine will be very beneficial in cutting short the disease.

When adenitis passes into suppuration, matter generally begins to form from the fifth to the tenth day, the event being usually most rapidly excited in young, weakly, or scrofulous children, with an impoverished state of the blood. The pus is not always situated in the enlarged glands ; in many cases, in fact, it is limited, in great degree, if not entirely, to the neighboring connective tissue. It is of a light yellowish color verging on greenish, thick, and often very copious ; occasionally it is mixed with blood, and with the débris of the affected glands. Finally, the matter may occur as an infiltration, or as a distinct abscess. The microscopical characters of pus from a lymphatic gland are seen in fig. 263.

Fig. 263.

Scrofulous Pus from a Lymphatic Gland. $\frac{250}{1}$

The occurrence of suppuration is announced by increased heat, pain, redness, and swelling, along with a sense of throbbing, and by high constitutional disturbance, attended by chilly feelings, or even rigors, followed by fever and perspiration.

The treatment is strictly antiphlogistic. If the phenomena are clearly denotive of the existence of pus, an early incision is made, free and dependent, to favor thorough evacuation and prevention of reaccumulation. The operation is followed by warm water-dressing or an emollient cataplasm. The use of a tent or drainage tube will occasionally be required to maintain patency of the puncture.

In regions of the body which are habitually exposed, as, for instance, the neck, and

where, consequently, it is of great importance to avoid unseemly scars, the best plan generally is to evacuate the pus by a series of small punctures, succeeded immediately by gentle pressure, the operation being repeated every two or three days until the matter ceases to form. Some surgeons, with the same end in view, use the aspirator, but I am not aware that the method possesses any advantage over the ordinary operation.

2. *Chronic adenitis* is a very common occurence, generally as a consequence of the acute form of the disease, but sometimes it is, apparently, a primitive affection. However this may be, its effect is gradually to subvert the natural structures through increased thickness of the reticulum and diminution in the number of the lymph cells, as in fig. 264, from Green. In the earlier stages of the disease, the gland is of a reddish, brownish, mottled hue, considerably increased in size, and of a firm, fleshy consistence; by and by, however, it assumes a grayish or whitish aspect, becoming almost homogeneous, and cutting very much like an unripe apple or pear; in some cases it is very soft and lacerable. When the transformation is very great, the hardness of the gland may be equal to that of scirrhus, with which it is then liable to be confounded. A distinct capsule, composed of dense connective tissue, generally surrounds the enlarged body, which is capable, in this condition, of attaining the volume of a small orange. When a number of such glands are agglomerated together, a large tumor is formed, of a hard, firm consistence, more or less adherent to the neighboring parts, and of an irregularly lobulated appearance, as in fig. 265, copied from one of my preparations.
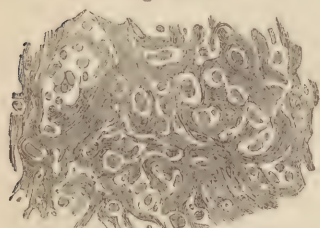
Fig. 264.

Chronic Inflammation of a Lymphatic Gland. $\frac{200}{1}$

Chronically enlarged or hypertrophied lymphatic glands are most commonly met with in the neck, or about the lower jaw. In the internal cavities they are most frequently seen in the mesentery and pelvis, and at the root of the lungs. The effect which these bodies exert upon the structures among which they are situated is principally of a mechanical character, compressing them, and so interfering more or less with the exercise of their functions. Thus, in the neck they may cause injurious compression on the trachea, vessels, and nerves; in the pelvis they may interfere with parturition by preventing the descent of the child's head; while in the lungs they may occasion suffocation by obstructing the entrance of air into the bronchial tubes.

Various causes may give rise to this affection; some of a local, others of a purely constitutional nature. In the neck, it is often occasioned by cold, or by disease of the jaw, teeth, gum, or tonsil; in the groin, by ulceration of the penis; in the axilla, by disorder of the mammary gland; in the mesentery, by irritation of the small bowel. The most efficient general cause is a strumous state of the system; but there is reason to believe that the lesion may be produced by anything that has a tendency to derange the general health, or to impoverish the fluids and solids.

Fig. 265.

Hypertrophied Lymphatic Glands.

Chronic enlargement of the lymphatic glands often continues for years, now advancing, then stationary, and now, perhaps, receding; in general, however, the disease is obstinate, especially when the structure of these bodies has undergone serious organic changes, in which case it is often extremely difficult, if not impossible, to reclaim them by any mode of medication, however perseveringly or judiciously employed.

The *treatment* of chronic adenitis is both constitutional and local. In the first place, the exciting cause is looked for, and, if possible, removed; the carious tooth is extracted, the ulcer on the penis healed. The general health is improved by attention to the bowels and secretions, and by strict hygienic observances. When plethora exists, detraction of blood, and antimonial and saline preparations, will be of service; under opposite circumstances, the proper remedies will be a nutritious diet, and alterant tonics, consisting of iodide of iron and quinine, bichloride of mercury, iodide of potassium, and cod-liver oil. When there is no contraindication, minute doses of mercury in

Huxham's tincture of bark will often be highly efficacious, but care should be taken not to carry it to decided ptyalism. Tartar emetic also, given in small doses, as the tenth or twelfth of a grain, three times a day, is frequently very beneficial. In most cases a regular system of purgation should be maintained. The German practitioners are fond in this disease of the use of chloride of ammonium, administered in doses of five to ten grains three times in the twenty-four hours. The article is a powerful sorbefacient, and is, therefore, worthy of trial, especially in cases which do not yield to the more ordinary measures. Quinine has often yielded excellent results in my hands.

Among the more important topical remedies are leeches, and sorbefacient liniments, unguents, and embrocations, conjoined with systematic and steady compression. These means must be employed with great caution and judgment, otherwise they will be sure to be productive of harm instead of benefit. All sorbefacient applications should, in the first instance, be of a mild character, their strength being gradually increased as the parts become more tolerant of their impression, and their peculiar effects are rendered more and more apparent. Of these one of the best is composed of one part of iodoform to two parts of balsam of Peru, and five of cosmoline. When the enlarged glands are favorably situated, compression will often be found to be a most valuable remedy, applied with the pad of a truss, as in hypertrophy of the inguinal glands, or with a compress and bandage when it affects the glands of the neck. In obstinate cases, a blister occasionally exerts a salutary influence, relieving the enlarged structures of engorgement, and stimulating the absorbent vessels so as to induce them to remove morbid deposits. The electric current has sometimes been advantageously used. Subcutaneous division of the enlarged glands, or comminution with the bistoury, has occasionally been practised, but the effects, at least in my hands, have not been such as to render a repetition of the operation at all desirable.

Finally, when the disease is intractable, the only resource is removal of the morbid mass, provided it be favorably situated for such a procedure. Such a step, however, should not be lightly taken, as it must often involve serious consequences, on account of the great depth of the tumor, and its connection with important structures. In the cervical region, for example, the excision of a mass of enlarged and indurated lymphatic glands not unfrequently proves a most difficult, embarrassing, bloody, and hazardous operation. Removal will be much facilitated if the knife be kept close to the hypertrophied glands. Sometimes the enlarged and disintegrated structures may be pressed out bodily through a small opening in the skin. When the diseased mass compresses the trachea or great vessels of the neck, and does not admit of removal, relief must be sought by the subcutaneous section of some of the constricting muscles, especially the sternocleido-mastoid.

3. The lymphatic glands are occasionally the seat of hyperplastic formations, termed *lymphomas*, or lymphadenomas, which, in their minute structure, consist essentially of a very delicate, reticulated stroma, inclosing lymph corpuscles in greatly increased numbers. The general features of this growth have been so fully described at page 218 that the merest reference here must suffice.

4. *Sarcomatous tumors* of the lymphatic glands are characterized by proliferation of the cells of the trabeculæ, with atrophy and final disappearance of the lymph follicles. Lymphosarcoma differs from ordinary lymphoma in the following particulars, the clinical features of the two affections being so distinct that a mistake in the diagnosis is scarcely possible. Commencing usually as a single tumor, it is not circumscribed by a capsule, but is diffused through the surrounding tissues, sparing neither the muscles, the bloodvessels, the sheaths of nerves, nor the adjacent lymphatic glands. Its growth is progressive and very rapid, enormous dimensions being attained in a short time, and, as it advances, it contracts adhesions with the skin, which becomes discolored and, finally, ulcerated. If extirpated, it is almost certain to return, and secondary deposits occur early in the lungs, liver, spleen, and skin. The dissemination may often be traced to embolism, the mass adhering to and perforating the walls of the large venous trunks, and permitting the detachment of small fragments, which are carried to distant organs by the blood.

In 1871, I removed a growth of this description, of the size of a large fist, from the neck of a gentleman, twenty-eight years of age. It was first noticed two years previously, and, after having attained the volume of a small orange, it remained stationary until six months before the operation, when, suddenly and without assignable cause, it took on renewed action. It was lobulated and elastic; the skin was discolored and closely adherent, and, on account of its deep and important connections, the dissection was tedious. Death occurred, apparently from cellulitis, on the tenth day. On micro-

scopical examination, the neoplasm was found to be composed of closely-packed, small, round cells, with large nuclei and bright nucleoli, the intercellular substance being sparse and homogeneous.

5. *Tubercular* disease of these bodies, as stated in the chapter on scrofula, is met with chiefly in young subjects, before and soon after the age of puberty; most generally in children. Now and then it occurs in elderly persons, but this is very uncommon. Surgically considered, it is most frequent in the glands of the neck and jaw, and may be limited to one of these bodies, or, as is most generally the case, affect a large number, either simultaneously or successively. It often coexists with tubercular disease of the lungs, joints, and other parts. The proper remedy, when the disease is not too far advanced, is excision with a view to prevent infection of other organs.
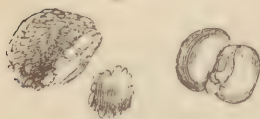
Fig. 266.

Cretaceous Degeneration of the Lymphatic Glands.

6. The lymphatic glands occasionally undergo *earthy degeneration*, as in fig. 266, being converted into a soft, whitish substance, not unlike chalk. Such an occurrence is most common in the bronchial and mesenteric glands, but is also sometimes seen in those of the neck. Not long ago I met with a case in which not less than five of the cervical glands had become completely calcified, being of stone-like solidity, of a light brownish color, rounded, and from the size of a pea to that of a hazelnut. The patient was a middle-aged, strumous woman, and the glands, forming a chain along the inner edge of the sterno-cleido-mastoid muscle, on the right side, had been affected from early youth. Their character was obvious on the slightest touch. Excision was easily effected. Such tumors need not be interfered with, unless they are a source of annoyance by their situation.

CHAPTER V.

DISEASES AND INJURIES OF THE ARTERIES.

SECT. I.—WOUNDS AND HEMORRHAGE.

THERE can be no more terrible and appalling sight to a patient and his friends than hemorrhage from a divided artery, especially when the blood is gushing out in a full and angry torrent, threatening every moment to put an end to existence. There is something indescribably sickening and distressing in such a scene, from which every sensitive mind shrinks with dismay and bewilderment. The horror of the scene is increased a hundred-fold when we are unable to afford the requisite relief. But the sight of blood is not disagreeable only to the common observer; there are few surgeons, however heroic or well disciplined, who do not, at times, participate in this feeling. If it were not for the frightful hemorrhage which so frequently attends them, operations would be divested of nearly all their terror, and few men would shrink from their performance. Fortunately or unfortunately, however—for it is not easy to determine which—this is not the case; the slightest incision is often followed by profuse bleeding, and in the extirpation of tumors, in the removal of limbs, and in various other procedures, the patient has reason, in many cases, to congratulate himself if he do not perish from the loss of blood. Some of the more serious accidents, as incised, gunshot, and punctured wounds, often prove instantly fatal from hemorrhage; or, if syncope should, luckily, ensue, and thus temporarily arrest the bleeding, death may occur subsequently, but not less certainly, from the same cause. It is for these reasons that hemorrhage has always been a source of so much anxiety to the surgeon, and that its study has engaged so large a share of his attention from the earliest stages of medical science down to the present time. It is, indeed, impossible for him to be too well acquainted with the subject, or too thoroughly prepared to meet its various, trying and painful emergencies. The reflection, which must often arise under such circumstances, that possibly all was not done that might have been done if greater skill had been exercised, is well calculated to overwhelm the sensitive and conscientious surgeon, and to induce a degree of distress which no one, who had not himself experienced it, can possibly appreciate. I do not envy the feelings of that man who, through ignorance,

inattention, or indecision, allows his patient to perish from loss of blood when he ought to save him.

The characteristics of arterial hemorrhage are, first, the scarlet color of the blood, and, secondly, the peculiar manner in which it issues from the injured vessel; it spirts out in jets, synchronously with the contraction of the left ventricle, and not in a steady, continuous stream, as when it comes from a vein. This, however, is true only of the larger arteries; for, when the smaller branches are severed, their contents escape very much like those of a vein, only more forcibly, the fluid even then often projecting to a distance of several feet. When one of the principal trunks is divided, the blood is frequently sent with great violence to the ceiling, or far across the room, to the horror and dismay of every one present. It is worthy of note that arterial blood in a person partially asphyxiated, or fully under the influence of an anæsthetic, is of a dark color, like that of venous blood. The effects of hemorrhage vary very much, and are not by any means always in proportion to the extent of the injury. When proceeding from a large artery, or a considerable number of small ones, it may prove almost instantly fatal, or, at all events, in a few minutes. In general, however, the case does not progress so rapidly. The patient, after the bleeding has continued for some time, is seized with syncope, and now, the heart's action being greatly depressed, an opportunity is afforded for the formation of a clot both within and around the artery, followed by an arrest of hemorrhage. By degrees reaction takes place, color returns to the cheek, the extremities become warm, and the pulse reappears at the wrist. With these phenomena recurs the danger of bleeding. As the heart's action augments, the blood is again vigorously propelled through the body, and, presently, the temporary clot being washed away, the wound is reopened nearly, if not quite, to its original extent. Again fainting occurs, a new plug is formed, and for a time life is once more free from immediate risk; but this truce, like the first, is of short duration; the same scene is reënacted a second and a third time, until at last, by the repeated drain, the heart and the brain are no longer capable of supporting each other in the fearful struggle, and the patient sinks completely exhausted.

A person dying from repeated losses of blood, consequent upon the division of a large vessel, presents a fearful picture. His countenance is ghastly pale; his pupils are widely dilated; he pants and sighs for breath; his ideas are vague and confused; he is sick at the stomach, and vomits; the extremities are icy cold; and the whole surface is covered with a profuse, clammy perspiration. The thirst is usually intense and unquenchable, the largest quantity of water failing to satisfy the urgent wants of the system; excessive restlessness and jactitation succeed; the patient calls loudly for cold air; paroxysm after paroxysm of swooning recurs; the pulse has, perhaps, already been long absent from the wrist; the eyes assume a glazed and fixed expression; the respiration grows more and more feeble; and death often steals on so imperceptibly as to render it difficult to determine the precise moment of its occurrence. During all this time, whether it embraces only a few minutes or hours, or whether it extends through several days, there is generally an entire absence of pain, the loss of blood operating as an anæsthetic.

The reaction which follows upon copious loss of blood is generally attended with high excitement, known as "hemorrhagic fever." The symptoms which characterize it are peculiar. The blood, the natural stimulus of the heart, is utterly inadequate for the wants of the system, and hence, to send a certain supply to the more important viscera, especially the brain and lungs, as well as to its own substance, the organ is obliged to make extraordinary efforts, as is shown by the tumultuous nature of its action. The pulse is unusually soft and frequent, and accompanied with a peculiar jerking, vibratory sensation, distinguished as the hemorrhagic pulse, the skin is hot and dry, the countenance is slightly flushed, the eyes are suffused, the thirst and restlessness are intense, distressing noises are complained of, the head aches, and the temples throb and feel as if they were constricted by a cord. Nausea and vomiting are often present; the sleep is imperfect, and the mind not unfrequently wanders. If prompt relief be not afforded, the patient may perish from effusion of serum into the arachnoid sac and into the pleuritic cavities. The most suitable remedies are perfect rest of mind and body, cold applications to the head, frequent sponging of the body with tepid water, and full doses of morphia in union with the neutral mixture. Beef essence, chicken broth, and milk punch constitute the most appropriate diet. As soon as the condition of the stomach will admit of it, iron and ergot, or ergot and acetate of lead, should be freely given to increase the plasticity of the blood. If, during the progress of the case, the brain and lungs are threatened, the main reliance must be upon blisters and dry cupping, with, perhaps, in the former case, a few leeches to each temple. Light and noise must, of course, be excluded from the apartment.

When the hemorrhage has been excessive, as indicated by the pallor of the countenance, the feebleness of the pulse, and the gasping character of the breathing, transfusion of blood, as a dernier resort, should be employed. The operation, if not performed too late, is very encouraging, the statistics of Landois affording not less than 65 recoveries out of 99 cases, more than one-third of the fatal cases being moribund at the time.

Fig. 267.
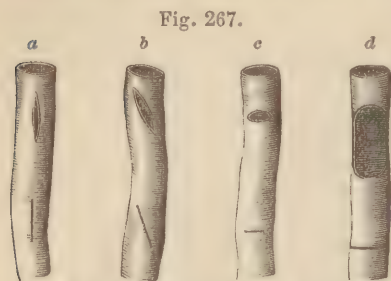
Plan of Wounded Arteries. *a.* A mere Longitudinal Slit, extending to an oval space. *b.* A Similar Wound, in an Oblique Direction, gaping more. *c.* A less Wound transverse, with the proportional gaping great. *d.* A Transverse Wound of the same size at *a* and *b*, causing a very wide hiatus.

Wounds.—If we inquire into the nature of wounds of the arteries, it will be found that they do not differ, as it respects the weapons with which they are inflicted, from wounds in other tissues. Thus, they may be incised, punctured, lacerated, contused, or gunshot, and it would frequently be difficult to determine which class is the worst, or the most certainly and speedily fatal. In regard to their size they present every possible gradation, from the slightest incision to the complete division of the vessel; the wound being either oblique or transverse in the latter case, but of various shapes when the lesion is partial. Occasionally the wound consists of a mere vertical fissure. The different appearances here alluded to are all well displayed in fig. 267. The extent and character of the wound necessarily exert great influence upon the amount and duration of the hemorrhage, and, therefore, demand careful study.

When an artery has been completely cut across, there is an instantaneous and impetuous flow of blood, followed immediately by the retraction and contraction of each end of

Fig. 268.

Contraction of a Divided Artery. *a.* The Orifice of a Dead Artery. *b.* The Orifice of a Living Vessel immediately after Section.

Fig. 269.

Plan of Natural Hemostatics, in a Cut Artery. At *a*, the Cut End of the Arterial Tube; Conical by Contraction. At *b*, the Arterial Sheath Vacated by the Retracted Artery, and Occupied by Coagulated Blood. At *c*, the Coagulum Projecting from the Orifice of the Sheath.

the vessel, as exhibited in fig. 268. The effect of this double action is to diminish the amount and force of the stream, but not to arrest it; instead of this, it usually continues until a coagulum has formed upon the orifice of the artery, as well as in the parts immediately around, particularly in the loose connective tissue constituting its sheath. In this manner a mechanical obstacle is opposed to the effusion of blood, but this would soon be washed away if it were not aided and fortified by the speedy development of a coagulum within the vessel, extending usually as high up as the first large collateral branch. These clots, of which the first bears the name of external, and the other that of internal, fig. 269, are the means which nature employs to put a stop to the hemorrhage; not, however, until, as a general rule, it has proceeded to the extent of syncope, a circumstance always eminently favorable to the coagulation of the blood, and, consequently, also to the formation of the clots now described. But these clots, at this stage of the process, are necessarily very soft, as well as very imperfectly adherent; hence, in order to guard against their detachment, or, what is tantamount to this, against a recurrence of the hemorrhage, it is indispensable that these parts—clots, vessel, and surrounding structures—should become effectually and permanently soldered together. This accordingly soon happens; for within a few hours after the occurrence of the injury inflammation is enkindled, both in the divided artery and in its sheath, and this is followed by the proliferation of the endothelial cells of the internal coat and of the fixed cells of the sheath, and their extension into the clots, and the appearance of

colorless blood corpuscles, which are partly resident in the clots, and partly intruders from without. This new cellular tissue fixes the clots, and is subsequently transformed into connective tissue; and vessels finally show themselves, some of them being of new formation, while others, and perhaps the greater number, are derived from the divided artery and its sheath, as well as from the surrounding structures.

The two clots now described are, it will be seen, inseparably blended at the orifice of the divided vessel, and their form and arrangement may not inaptly be compared to a glass stopper, closely fitted into the neck of a decanter. The outer clot is rough and irregular, whereas the internal is perfectly smooth and cylindrical, except its cardiac extremity, which is nearly always conical. The longer the internal coagulum is the less danger will there generally be of its premature detachment.

Fig. 270.

The changes above mentioned as occurring in the two clots are generally the work of time; the gluing process is usually effected rapidly, since its function is to protect the patient against hemorrhage; but the removal of the serum and coloring matter of the blood, and the conversion of this fluid into solid matter, take place more slowly, and are often not completed under several months. Finally, if the parts be examined at a still later period, it will be found that both clots have entirely disappeared, and that the injured vessel, as high up as the first large collateral branch, has been transformed into a dense, strong, fibrous cord, fig. 270, similar to that observed in the umbilical arteries of the infant.

Such, then, is the process which nature employs for arresting the flow of blood from a divided artery. Taking advantage of the exhausted condition of the system consequent upon the shock and loss of blood, she instinctively forms the two clots, having, first of all, drawn away the vessel from the main wound, as well as caused it to diminish its caliber, and then she goes deliberately to work to fasten these clots at points precisely where they are most needed for the purpose. The ves-

Change in the Shape and Structure of an Artery after Ligation.

sel being thus hermetically sealed, she afterwards busies herself still further in getting rid of these plugs, as they now are no longer required, and, finally, completes the labor by converting the obsolete extremity of the artery into an analogous tissue. These changes, so profoundly curious and interesting, bear, it will be perceived, a very close resemblance to those which take place in the callus of a broken bone.

After the ligation of an artery, the supply of blood in the parts beyond the seat of the obstruction is maintained by what is called the collateral circulation, the vessel above communicating freely with that below, as in fig. 271, by its anastomosing branches.

Fig. 271.

Diagram of Collateral Circulation.

When an artery is divided only partially, whether transversely, obliquely, or longitudinally, an external clot forms, but this is generally so imperfect as to render it incapable of opposing an effectual barrier to the flow of blood. The edges of the wound, however small, have a constant disposition to gape; and hence, although plastic matter may, perhaps, be deposited in great abundance, yet it is impossible for the parts to contract permanent and satisfactory adhesions to each other. As soon as the circulation regains any of its natural vigor, the blood as it sweeps along washes off the clot, and appears upon the exterior of the wound; and thus the hemorrhage usually continues, paroxysm after paroxysm recurring in more or less rapid succession, until it proves fatal.

Although such is the course usually pursued when an artery is only partially divided, experience has shown that a spontaneous cure does occasionally take place. Such an event, which, however, at best is extremely uncommon, is most likely to occur when the opening is longitudinal; when the wound in the overlying structures is a mere fissure or canal, offering an imperfect outlet to the contents of the vessel; when the system remains for a long time in a prostrate condition; and when, finally, there is a very rapid and abundant deposit of plasma in the various tissues involved in the lesion, serving to glue them speedily and firmly together. That an incised wound, however, of considerable size, is sometimes healed in this manner, is proved by what occasionally happens when the brachial artery is injured at the bend of the arm in venesection.

Punctured wounds of the arteries are dangerous or otherwise, according to their size and the size of the affected vessel. If a pin be thrust into a large artery of an animal, and immediately withdrawn, a drop of blood exudes, but there is no further bleeding, the aperture being promptly closed by the natural elasticity of the coats of the vessel. Whether a similar effect follows such an occurrence in the human subject is not positively determined. Mr. Guthrie mentions a case in which fatal hemorrhage was produced by wounds of the carotid artery inflicted by pins; and he refers to two instances in which a similar result was witnessed from a puncture of the femoral artery made with a tenaculum. On the other hand, it is a well-known fact that acupuncture needles have repeatedly been inserted into the largest arteries with perfect impunity. It is very probable that an instrument of small size will produce different effects, so far as hemorrhage is concerned, in a denuded artery and in an artery that retains its natural relations, the blood, owing to the difference in the atmospheric pressure, being more readily forced out in the former than in the latter. However this may be, it is a matter of paramount importance, in performing operations upon the arteries, to avoid even the most delicate puncture, since such an accident might be followed by ulceration, and serious, if not fatal, hemorrhage.

Wounds inflicted by small shot partake of the nature of punctured wounds. In two cases of this kind under my charge, one involving the subclavian and the other the femoral artery, the openings made by the shot were found to be perfectly closed in less than three weeks after the accident. In gunshot wounds the hemorrhage is usually copious, if not speedily fatal, whether the artery, especially if it be one of large size, be partially or completely divided. When the coats are badly contused, or bruised and lacerated, as when they are grazed by the missile, secondary hemorrhage may be expected from ulceration or gangrene.

When the outer and middle coats of an artery are dissected off to a slight extent in an animal, no bleeding takes place, because the current of blood is not sufficiently strong to rupture the inner tunic; but such an occurrence in the human subject is fraught with great danger, as it is almost inevitably followed by fatal hemorrhage. A case recorded by Mr. Guthrie strikingly illustrates this fact. A man cut his throat with a razor, the instrument inflicting a transverse wound upon the carotid artery, but did not penetrate beyond the middle coat. The vessel gave way at the point of injury on the eighth day, and the patient died of hemorrhage. When an artery is nicked with a knife or forceps, as occasionally happens in the extirpation of a tumor with unusually firm and extensive adhesions, safety demands that the vessel should immediately be secured with the ligature. When the internal and middle tunics are divided, as in case of accident, the external, if severely injured, will be very liable to be assailed by ulceration; whereas, if it retain its integrity, the probability is that it will be gradually expanded into an aneurismal pouch, the more especially if it has undergone the atheromatous or calcareous degeneration.

Contused and lacerated wounds of the arteries generally bleed much less freely than incised and punctured. Occasionally, indeed, there is no hemorrhage whatever, even when the largest arteries are involved in the injury, and their denuded extremities are hanging loosely on the exposed tissues. In some instances the hemorrhage is momentarily profuse, and then ceases permanently; in other cases it continues, and proves speedily fatal. The reason why there is generally so little blood lost in injuries of this description is, as is fully explained in the chapter on wounds, that the ragged and paralyzed coats of the artery readily intercept the blood, and that the blood itself, in lesions involving the separation of an entire limb or the rupture of the larger vessels and nerves, always coagulates much more promptly and firmly than in ordinary incised wounds, the shock sustained by the system being highly conducive to the occurrence. Sometimes an effectual barrier is opposed to the effusion of blood in a ruptured artery by the sheath being drawn forward over its mouth, in the form of a hood.

When an artery is severely contused in its continuity, the resulting inflammation may be so great as to cause complete occlusion of the vessel at the seat of the injury, the blood coagulating as it sweeps over the affected surface, and the clot becoming firmly adherent through an abundant effusion of lymph. Or, instead of this, ulceration or gangrene may occur, and the patient may die of hemorrhage, as not unfrequently happens after gunshot injuries, the bleeding usually coming on within the first eight or ten days after the infliction of the wound.

But, although nature may, and, indeed, sometimes does, arrest the hemorrhage from a divided artery, yet no sensible surgeon would intrust her with such an office, when it is in his power to get at the seat of the wound ; for it is hardly possible to conceive of a case involving one of the larger trunks where her efforts would be likely to be successful, or where, if ultimately triumphant, the patient would not be brought repeatedly at death's door before she could attain her end. It is only in wounds of the internal arteries, as those of the chest and abdomen, and in the aorta and its larger branches, that we must refrain from direct interference, and limit ourselves to the use of general means calculated to keep down vascular action, especially the liberal use of anodynes and sedatives, as opium, aconite, and acetate of lead, the application of ice over the seat of the injury, exposure of the patient to cold air, and perfect quietude of mind and body. All active exertion must for a long time be avoided, in order that, if a cure should take place, the wound may not be suddenly reopened by the giving way of its edges, in consequence of the imperfect organization of the clots and of the plasma.

Treatment.—The means employed by art for suppressing hemorrhage are quite numerous, as well as greatly diversified in their nature, and will, therefore, require to be considered somewhat in detail. The most important of these means are : first, ligation ; secondly, acupressure ; thirdly, compression ; fourthly, torsion ; fifthly, forced flexion ; and, sixthly, styptics. Besides these, there are several others of a subordinate character, meriting merely a passing notice.

1. *Ligation.*—Ligatures are composed of various materials, as silk, linen, and soft leather. Of these, the first is the most unexceptionable, and almost the only one now employed. It should be round, smooth, well twisted, colorless, and so strong as not to break without considerable effort. For the smaller arteries, as the radial, tibial, and temporal, common sewing silk is well adapted ; but for the larger trunks, as the femoral, iliac, and carotid, stay silk, a much stouter article, is required. Some practitioners prefer what is called dentist's silk, no matter what may be the size of the vessel, on the ground that it is much stronger in proportion to its thickness than any similar substance, and, therefore, less liable to excite undue irritation. This thread, which is employed in making fishing lines, is rendered very hard and stiff by means of gum, which, however, is easily removed by boiling it for a few minutes in a slightly alkaline solution. Treated in this manner, a piece long enough to tie the iliac artery will hardly weigh the twenty-fifth of a grain. Hemp or linen thread makes an excellent ligature ; and, in case of emergency, a sensible surgeon will not hesitate to take anything that may be in his way. Whatever substance be employed, it is very important that it should be thoroughly waxed, otherwise it will be difficult, if not impracticable, to draw and tie it with a requisite degree of firmness, to say nothing of the greater tendency of the knot to slip. From eight to ten inches is a good average length for a ligature.

Animal ligatures were first introduced to the notice of the profession by Dr. Physick, early in the present century, and they have ever since been occasionally employed by different practitioners, chiefly American. The late Dr. Jameson, of Baltimore, used them nearly altogether for many years, under the belief, founded upon numerous experiments and clinical observations, that they were decidedly superior to all others, their presence never causing any of the irritation which so often follows the application of the ordinary substances. The article to which he gave the preference was soft buckskin leather, cut into thin, narrow strings, not tied too firmly, lest they should break, and be thus prematurely detached. Ligatures made of the fibrous elastic coat of the aorta of large animals have been introduced by Mr. Barlow. Dr. Ishiguro, of the Japanese army, strongly recommends the use of ligatures prepared from the tendon of the whale ; they are sufficiently strong to bear heavy pressure, do not cause irritation, and, although they are readily absorbed, they retain their hold long enough to prevent secondary hemorrhage. Mr. Croft, in 1881, tied the external iliac artery with a ligature made of the tendon of the kangaroo, and found great reason to be satisfied with the result. Other practitioners recommend catgut, or ligatures manufactured from the small intestine of the sheep, and others, again, the fibres of the sinew of the deer, the latter having been found to be particularly useful

by Professor Eve ; while the former, rendered antiseptic by immersion in a weak solution of carbolic acid, has been highly lauded by Mr. Lister. The advantage of the animal ligature is that, besides approaching more nearly to the living tissues than any other material, the ends may be cut off close to the knot ; its disadvantage, as formerly prepared, is that it soon becomes softened and disintegrated, from the imbibition of fluids, thereby rendering it liable to separate before it has accomplished the object for which it was applied. This objection, however, is overcome by steeping the catgut for two weeks in chromicized glycerine, a process by which it is greatly strengthened, drying it, and afterwards storing it in a one-to-five solution of carbolic acid and glycerine. Dr. Macewen, of Glasgow, has found that the best mixture for rendering the substance capable of resisting the action of the tissues for a fortnight is made by adding one part of a one-to-five watery solution of chromic acid to five of glycerine. For arteries of large size, the violin string, " E, No. 70," answers an excellent purpose. Prepared in the above manner, I believe that the catgut ligature is less liable than the ordinary ligature to be followed by suppuration, ulceration, and secondary hemorrhage ; and I have, therefore, no hesitation in giving it my entire approval. It is now fully ascertained that the carbolized catgut ligature is generally entirely absorbed within a few weeks after its application, and that its action on the coats of the artery is similar to that of hemp or silk, with the important exception that the outer tunic is not ulcerated. Dr. G. F. Arnaud recently tied the carotid or femoral artery fourteen times in dogs, which were afterwards killed at periods varying from four to sixteen days. In nine cases the ligature had entirely disappeared ; in two it was partially absorbed ; and in three it was little altered. In twelve of the cases the inner and middle tunics were divided, or the middle alone. The clot, when not absorbed, was very small, and the obliteration of the vessel was complete and firm. Pure raw silk is at present being employed as a substitute for catgut, but with what success remains to be determined.

Of late years the attention of surgeons in this country has been repeatedly directed to the use of metallic ligatures for tying arteries. The innocuous character of lead, gold, silver, and platinum wire, thus employed, was fully established by Dr. Henry S. Levert, of Mobile, in a series of experiments which he performed in 1828, and an account of which was published in the fourth volume of the American Journal of the Medical Sciences. The results proved not only that the inflammation consequent upon the operation was generally comparatively slight, but that in nearly every instance the metallic thread became speedily encysted, and might, if it had not been purposely removed, have remained for an indefinite period as a harmless tenant in the parts. Dr. Stone, of New Orleans, in 1859, tied the common iliac artery with a silver wire, and I soon afterwards secured the femoral in a similar manner. Since then I have adopted the procedure in a number of cases, and on two occasions I have left a metallic ligature permanently around the spermatic cord after extirpation of the testicle. In 1866, Dr. C. H. Mastin successfully tied the external iliac artery with silver wire, and in the same year I performed a similar operation upon the same vessel with equally good results. A number of other examples, of later date, might be cited, but this is unnecessary, as the safety and value of the operation are fully established.

Fig. 272.

Toothed Artery-forceps.

The wounded artery may be very conveniently drawn out with a pair of toothed forceps, fig. 272, with a tenaculum, fig. 273, or, what generally answers the purpose exceedingly well, an ordinary pair of pocket forceps. If the vessel is small, it should be seized in its longitudinal axis, but in the horizontal if it is large, since it is more easy in this way to occlude its orifice, and prevent the flow of blood. It is for this reason, also, that the forceps are generally to be preferred to the tenaculum ; the latter instrument,

Fig. 273.

Tenaculum.

however, possesses an advantage over the former when the artery is cut off very closely, or when it is desired to include some of the surrounding tissues. Care must be taken not to transfix the coats of the vessels, and then tie the ligature below the point of perfora-

tion, as this might lead to secondary hemorrhage. When no good assistant is at hand, the artery-forceps, delineated in fig. 274, an instrument with broad, serrated extremities, and a movable slide or catch, to close the blades, will be found convenient.

Fig. 274.

Sliding-forceps.

Dr. Prince, of Illinois, has devised a contrivance for seizing arteries, called the tenaculum-forceps, represented in fig. 275. As the names implies, it combines the advantages

Fig. 275.
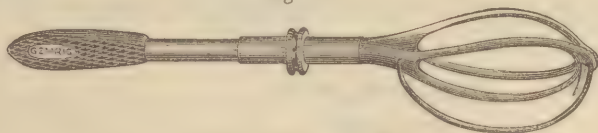
Prince's Tenaculum-forceps.

of the two instruments, and may be applied with great efficiency to all arteries of medium size, as the blades are sufficiently wide to effect complete occlusion of their caliber.

The vessel being pulled gently out, as in fig. 276, is carefully isolated from its connections, either with another pair of forceps, the finger, or the knife, or all three together, as may be most expedient. The propriety of excluding from the ligature the smallest nervous filament, as well as the most insignificant vein, and every particle of muscular tissue, is too obvious to require any comment. Such a proceeding is absolutely necessary, not only to prevent pain and suppuration, but to promote the separation of the ligature. It is only when the vessel is very small that any of the tissues in which it is embedded should be included in the ligature. The ligature is applied to a sound portion of the artery, immediately above the instrument, and tied into a single knot, when it is drawn so firmly as to divide the inner and middle tunics, as in fig. 277, if the artery is large, or

Fig. 276. Fig. 277.
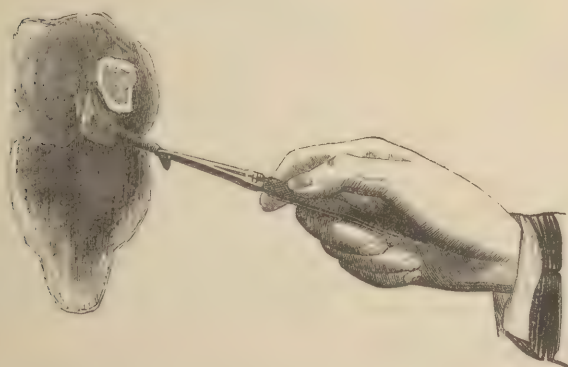
Mode of Drawing Out and Isolating an Artery.
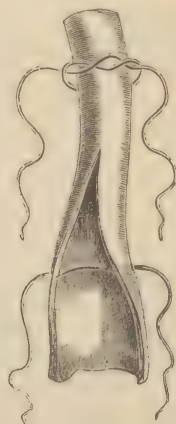
Effects of Ligation upon the
Inner Coats of the Artery.

even of medium caliber; while, in the smaller branches, mere contact of the opposite surfaces is aimed at. In executing this part of the operation, the extremities of the ligature should be wound around the fore and middle fingers of each hand, while the thumb is extended upon them nearly as far over as the vessel, in order that the force may be exerted as gently and equably as possible. Nothing is more unseemly, or more truly reprehensible, in a surgeon or his assistant, than to pull a ligature by fits and jerks,

or so violently as to break it, or, perhaps, lacerate and tear off the artery itself. With a little care and gentleness, a comparatively weak ligature may be thrown around a vessel so as to answer the intention most fully. I dwell upon this point with some degree of emphasis, because it has happened to me to witness a very unusual number of these Herculean feats with the ligature, the men often pulling as if they had hold of a rope and piece of wood, instead of a delicate thread and artery. Fig. 278 shows the indented appearance of the artery after ligation.

The tying is completed with a double knot, when one end is cut off close, and the other brought out at the nearest angle of the wound. The knot which is thus made is the reef-knot, fig. 279, in which the ends of the thread lie across the artery, as in the lips of the wound in the ordinary interrupted suture. The surgeon's knot, fig. 280, is no longer used for the purpose, as, from the manner of making it, it is very irregular, and, consequently, ill adapted to the object. In tying very small vessels, sometimes only one knot is employed.

The practice of cutting off both ends of the ligature, and of closing the wound over the injured vessel, first suggested, towards the latter part of the last century, by Mr. Haire, of England, and subsequently so warmly lauded by Mr. Lawrence and Mr. Hennen, is

Fig. 278.   Fig. 279.   Fig. 280.

Reef-knot.   Surgeon's Knot.

Exterior of an Artery after ligation.
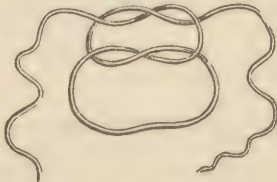
now universally abandoned, and very justly so, on the ground that the noose, after having performed its duty, creates irritation among the parts with which it lies in contact, leading thus to the development of abscesses, which continue to discharge so long as the foreign substance remains. When the ordinary animal ligature is used, this objection does not obtain, as the noose is soon removed by absorption, and a similar remark is applicable to the carbolized catgut ligature, which, when properly prepared, retains its hold sufficiently long to effect obliteration of the vessel without exciting undue irritation.

When the artery is diseased, or abnormally brittle, from the fibrous, cartilaginous, earthy, or fatty degeneration of its tunics, it may become necessary to employ a flat ligature, consisting of two or more silk threads, carefully waxed, and arranged side by side, or of a piece of soft, narrow braid, drawn so gently around the vessel as merely to approximate its serous surfaces. In using the round ligature, the division of the inner and middle tunics is aimed at, as this is most favorable to adhesion; but in this case the object is to preserve their integrity, so as to promote the retention of the cord until a permanent clot is formed. If this precaution be neglected, the cord may fall off permaturely, and thus occasion secondary hemorrhage. Instances occur in which the fragility of the arteries is so great as to render them incapable of bearing even this degree of pressure; and then the only resource is to include the vessel along with a portion of muscular or aponeurotic substance in a flat ligature. Such a procedure is much more rational than the practice, formerly recommended, of tying the vessel over a roll of adhesive plaster, an operation which could hardly fail to be followed by mischief.

In regard to the propriety of drawing the ligature so firmly as to divide the inner and middle tunics, no doubt is any longer entertained by enlightened practitioners. In the time of Scarpa much disputation prevailed respecting this point in the ligation of arteries, it having been alleged by this distinguished surgeon, on the strength of numerous experiments, that a cure could be effected quite as rapidly, and, in the end, more safely, simply by placing the serous surfaces gently in contact with each other. It was supposed that the part, treated in this way, would unite by direct adhesion, and that, consequently, when the ligature finally became detached, there would be much less risk of hemorrhage than when the vessel is lacerated and contused by the ruder method of procedure above described. Plausible as this theory may, at first sight, appear, it is found to be wholly unreliable in practice, for the very reason which induced Scarpa and his followers to

advocate its adoption, the ligature being not only a much longer time in separating, but the two ends of the artery being much less effectually occluded. When it is recollected that a certain degree of inflammation is necessary, after this operation, in order to afford the requisite amount of plasma, for gluing the inner clot to the surface of the vessel, it is reasonable to suppose that it would be much more easily induced by a partial division of the inner and middle tunics than by the mere approximation of the opposite sides of the tube ; and this is precisely what the general experience of the profession has at length established in relation to the subject.

When a considerable portion of neighboring tissue is obliged to be included along with the artery, the best instrument for performing the operation is a sharp tenaculum, with an eye near its point, as seen in fig. 281 ; a curved needle armed with a double ligature ; or Physick's artery forceps, fig. 282.

Fig. 281.

Fig. 282.

Tenaculum-needle, armed with a Ligature.

Physick's Artery Forceps.

An artery is sometimes rendered incapable of bearing a ligature in consequence of the softening of its tunics by inflammation. Such an event, which is often exceedingly perplexing, is most liable to happen in cases of secondary hemorrhage after wounds and amputations. The remedy is to isolate the vessel a short distance beyond its diseased limits, and to ligate it there in the usual manner ; or, this being impracticable, to tie the diseased part along with more or less of the surrounding tissues ; or, this also failing, to cut down upon and secure the main trunk of the artery.

In tying an artery in its continuity, whether as a means of arresting hemorrhage or of curing disease, the ligature is passed around the vessel by means of an aneurism-needle, fig. 283, a kind of blunt tenaculum, with an eye at the free extremity. The point of the instrument is gently carried around the vessel, without including any of the accompanying structures, steady counterpressure being made with the end of the forefinger, especially as it penetrates the connective tissue.

Fig. 283.

Aneurism-needle armed with a Ligature.

The precise situation of an artery is determined by its pulsation, and by its anatomical relations. Sometimes its course may be accurately defined by stretching a line from one point to another. At the commencement of the operation, the limb should be forcibly extended, as the muscles and tendons will then be rendered most prominent ; but, as the dissection proceeds, the object will be greatly promoted by flexing the limb in order to relax the soft parts. That the artery may not be wounded, its sheath should be carefully pinched up with the forceps, nicked slightly with the scalpel, as in fig. 284, from Erichsen, and then slit open to the distance of a few lines upon a grooved director. Isolation is best effected with the point of this instrument, either alone, or aided with the forceps and

Fig. 284.

Exposure and Opening of the Sheath.

finger nail. The proper sheath must be disturbed as little as possible, as it is intimately connected with the nutrient vessels, the injury of which might occasion softening, ulceration, or gangrene of the artery. The muscles are separated with the handle of the scalpel, without any material interference with the integrity of their fibres; and great care is taken, before commencing the incisions, to ascertain the situation of the superficial veins, by compressing the parts above the seat of the proposed operation, as it is very important that they should not be wounded.

The practice of applying two ligatures, and dividing the artery between them, is now very properly abandoned. The operation, which dates as far back as the time of Aetius, was revived by Mr. Abernethy, through whose influence it became for a while quite popular. It was soon found, however, that it was liable to be followed by secondary hemorrhage, owing chiefly to the injury inflicted during its execution, and it has, therefore, deservedly fallen into desuetude.

It was also in the operation of Aetius that some of the surgeons of the last century employed what was termed the reserve ligature, intended as a ready resource in sudden emergencies. The cord was placed loosely around the artery, to be tied instantly in the event of hemorrhage, from the premature detachment of the original ligature. Experience, however, soon showed that the procedure, instead of answering the design for which it had been intended, had a direct tendency to bring about the mischief, from its liability to produce ulceration of the denuded and tortured vessel. Its evils, indeed, are so palpable that there is no probability that it will ever be revived by any intelligent surgeon.

When an artery as, for instance, the femoral, is cut completely across in the continuity of a limb, two ligatures are necessary, one for the cardiac, and the other for the distal, extremity of the vessel. The reason of this is that, however securely the cardiac end may be tied, there will inevitably be more or less hemorrhage from the lower end, unless this be tied also, in consequence of the activity of the recurrent circulation. Every one who has ever had occasion to ligate the brachial artery at the bend of the arm, on account of injury inflicted upon the vessel in bleeding, must have seen that the hemorrhage was only partially controlled by tying its upper extremity. The blood, under such circumstances, wells up from the lower part of the artery as water bubbles up from the bottom of a spring; it does not issue in jets, or in a saltatory manner, as when it proceeds from the upper orifice, but lazily, and of a dark color, the bleeding resembling that of a vein rather than of an artery; and thus the hemorrhage goes on, with little or no intermission, until it is arrested by ligature, or until it proves fatal. The flow may, it is true, be temporarily stopped, during an attack of syncope; but even then seldom perfectly, for the reason, apparently, that the vessel here does not possess the same power of contraction and retraction that it does above, and is, therefore, not capable of forming any efficient clot, either external or internal.

The changes which occur in an artery after the application of a ligature are essentially similar to those which occur when the bleeding is arrested spontaneously. The first thing that happens, after such an operation, is the coagulation of the blood within the artery as high up, generally, as the first considerable collateral branch, thus forming what is named the internal clot. The external clot is, of course, wanting, a circumstance which constitutes the main difference in the two cases. The injured tunics, becoming inflamed, the cellular elements, particularly those of the intima or internal coat, multiply, and they, along with wandering lymph cells, give rise to a plastic formation, which grows between the clot and the ligature, and firmly and permanently fixes the former in its situation. In the course of a few days granulations spring from the plastic formation, extend into the clot, and cause it to disintegrate and finally to disappear. At about the sixth day the plastic formation begins to show signs of organization, and is soon permeated by a rich capillary network. Between the fifteenth and twentieth day, an anastomosis is established between the former vessels and those of the wall of the artery, the communication being established at the point at which the internal and middle coats have been divided by the ligature. Finally, after an indefinite period, the plastic formation being transformed into cicatricial tissue, disappears, and the corresponding portion of the artery is converted into a dense, fibrous cord.

The changes experienced by the arteries, the clot, and the plastic formation in their interior, after the application of the ligature, are admirably illustrated in the adjoining sketches from Dr. E. O. Shakespeare, to whose researches we are mainly indebted for a knowledge of the part played by the endothelial elements of the internal coat of the vessels in the process of repair. Fig. 285 represents a transverse section of the femoral artery of a dog forty-eight hours after deligation. At a and c the external and adventitious coats show proliferation of their cellular elements; at m the same change has occurred in

the middle tunic; at *e* the folds of the elastic layer of the inner coat are still very distinct; and at *p* the plastic material, formed principally by proliferating endothelial cells, is very conspicuous. Fig. 286 exhibits the artery eight days after the operation. At *p* granulations are seen springing from the plastic formation. They consist of spindle cells, the direction of the long axis of which is in the main parallel to the axis of the granulations.

Fig. 287, from O. Weber, represents the artery fifty days after deligation: numerous vessels are seen coming from the external coat, *Z*, to communicate with the newly-formed vessels of the plastic clot, *Th.*

Effects of Ligation, at the end of Forty-eight Hours.

It is impossible to state, except in a general manner, how long an internal clot must be in order to effect thorough closure of an artery, so as to prevent hemorrhage on the separation of the ligature. There is unquestionably less danger of hemorrhage when the distance between the ligature and the first large collateral branch is considerable than when the reverse is the case; and yet instances not unfrequently arise in which no bleeding takes place, although there is hardly any internal clot at all. Such an occurrence can only be explained upon the assumption that the plasma poured out during the progress of the inflammation provoked by the pressure of the ligature serves under such circumstances the purpose of a clot, which, hermetically sealing the mouth of the vessel, opposes an effectual barrier to the effusion of blood on the detachment of the ligature. Secondary hemorrhage will be most likely to occur when there is extensive separation of the sheath of an artery, in our attempts at isolation, thereby cutting off the supply of blood and nerve fluid from its tunics, and, as a necessary consequence, causing gangrene and premature detachment of the slough. In such an occurrence, which is sometimes unavoidable, the best plan is to adopt the practice of Professor Toland, of San Francisco, of employing two ligatures applied in such a manner as to exclude the denuded portion of the vessel entirely. The operation is based upon the fact that the integrity of the sheath of an artery is just as necessary to the preservation of its vitality as the periosteum is to that of a bone.

The period at which a ligature is detached varies with many circumstances, of which the principal are, the size of the cord and the manner in which it is tied, the state of the
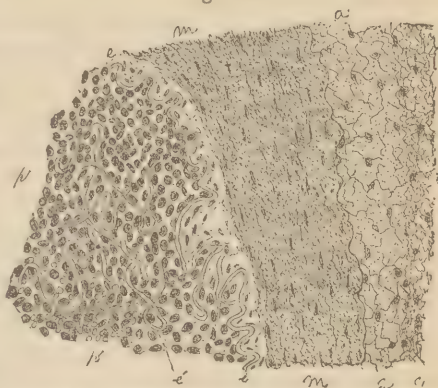
Fig. 286.
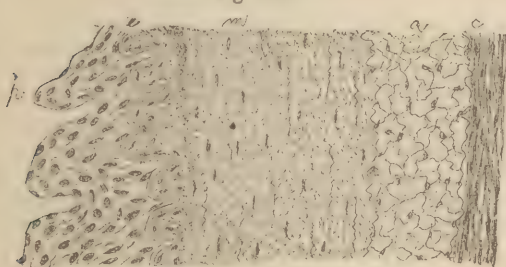
Effects of Ligation, at the end of Eight Days.

Fig. 287.

Effects of Ligation, at the end of Fifty Days.

artery, and the amount of the resulting inflammation. A small ligature will, other things being equal, be separated sooner than a large one, and a firm sooner than a loose one; a sound artery will be longer in throwing it off than a diseased one, simply because it has more power of resistance. A ligature upon the brachial artery will generally be detached in about ten days; upon the femoral, in from twelve to fourteen; upon the external iliac, in sixteen; upon the common iliac, in about twenty-one. To this rule there are, of course, many exceptions. I recollect an instance in which, after an amputation of the leg, the ligature was still

firmly adherent to the anterior tibial artery at the end of the fourth month. Dr. Lopez, of Mobile, communicated to me the particulars of a case in which the separation was not effected before the end of the eleventh month; and Professor Eve met with one in which it did not take place until after the thirteenth month. Such occurrences usually depend either upon the faulty manner in which the operation is performed, or upon the presence of an extraordinary quantity of organized plasma, interfering mechanically with the detachment of the thread.

When a ligature is indisposed to come away, its separation may generally be promoted by making, once every twenty-four hours, gentle traction upon it; great care and judgment, however, must be exercised in performing the operation, otherwise the patient may not only be subjected to severe pain, but to the risk of secondary hemorrhage.

The detachment of the ligature is effected by ulcerative absorption, and, if the mass be carefully inspected, it will be found to embrace a dead portion of the artery in the form of a slough.

When the cord is drawn very tightly, the corresponding part of the artery is strangulated, if not at once, at any rate, within a few hours; but, in general, the process takes place more tardily, and thus affords the two ends of the vessel time to prepare and fortify themselves for the approaching crisis. If we study the whole subject minutely, it will be found to embrace the following facts :—first, the strangulation and death of the vessel at the site of the ligature; secondly, the adhesion of the clot to the inner surface of the vessel, speedily followed by its replacement by organized tissue; thirdly, ulceration and the consequent separation of a part of the artery, thus producing a gap in its continuity; and, lastly, the disappearance of the new tissue and the transformation of each extremity of the tube into a dense, fibrous cord. In addition to these changes, there is occasionally slight suppuration, the matter usually presenting itself in the form of a little abscess. When an artery is tied at its extremity, as in an amputation or the extirpation of a tumor, the part of the vessel beyond the seat of the ligature mortifies, and is eventually detached as a slough.

Percutaneous—more properly called subcutaneous—ligation of the arteries in their continuity for the arrest of hemorrhage may occasionally be advantageously practised. It is particularly applicable to hemorrhage of the palm of the hand and sole of the foot, attended with inordinate swelling of the parts, rendering it difficult, if not impossible, to expose the bleeding vessel, and to tie it in a satisfactory manner. The operation consists, as the term implies, in carrying a stout needle, more or less curved, and armed with a strong thread, through the skin around the artery at a distance of one-third of an inch to an inch and a half from its track, so as to include a considerable portion of soft structure, and then bringing the needle out through the skin near the opening of entrance, and tying the ends of the thread over a roll of adhesive plaster. The vessel is thus firmly embraced in the loop of the ligature, which may generally be withdrawn by the end of the third day, or even before, as by that time complete occlusion will have taken place.

Subcutaneous ligation, mentioned by Ledran, in 1720, was originally practised by Professor Middledorpf, of Breslau, who has adduced a number of cases illustrative of its value. In this country the subject was first brought prominently before the profession by Dr. H. Z. Gill. The operation, which is performed with a slightly curved and somewhat flexible needle, armed with a thread or silver wire, is obviously not adapted to the larger arteries, as the ligature would necessarily include the corresponding vein, the obliteration of which might be followed by most disastrous consequences, independently of the compression of the large nerves, which are often in such close relation with the bloodvessels.

The discovery of the use of the ligature is due to Ambrose Paré, in the sixteenth century, prior to whose time surgeons were in the habit of stanching hemorrhage with the actual cautery, hot pitch, and all kinds of styptics, of the most cruel and barbarous nature. " For the good of mankind," says this great man, " and the improvement and honor of surgery, I was inspired by God with this good thought." Paré himself fully appreciated the utility of his invention, but his contemporaries spared no pains to undervalue it, and to revile and persecute its author, subjecting him to the humiliation of searching the writings of the ancient fathers of medicine for traces of the use of the ligature as a justification of his practice. Gourmelen, the jealous and malignant President of the College of Physicians of Paris, made himself particularly conspicuous on the occasion, and thus earned an infamous reputation; for the only act by which he is now remembered is his bitter and unrelenting persecution of Paré, rendered immortal by his great achievements.

2. *Acupressure.*—Acupressure, as a means of arresting hemorrhage, was devised by Sir James Y. Simpson, who published his first account of it in 1860; and, although it has attracted great attention since, more especially in Europe, and its results have, in the main, been of a very flattering character, time alone can determine its ultimate fate. That it is destined entirely to supersede the use of the ligature, so easy of application, so efficient in its action, and so universally approved, even its warmest advocates will hardly claim. In this country acupressure has made little progress; and, with the exception of Hewson, L. Weber, and Hutchison, all of whom have written able papers upon the subject, few, if any, prominent surgeons employ it. I have myself seldom used it, having always been satisfied with the harmless character of the ligature and its efficiency as a safe and ready hemostatic agent.

The advantages claimed for this operation over that of the ligature are, first, that it is more easy, simple, and expeditious of execution; secondly, that the acupressure needle does not, like the ligature, provoke irritation, much less suppuration, ulceration, or mortification at the seat of the constriction; thirdly, that the instrument may generally be removed, even in an artery of large size, as, for example, the femoral, at the end of the second or third day; fourthly, that the wound, other things being equal, is more liable to unite by the first intention; fifthly, that there is much less risk of erysipelas, pyemia, phlebitis, abscesses, traumatic fever, and secondary hemorrhage; and, lastly, that it may be safely employed in diseased arteries, too soft, brittle, or friable to bear the pressure of a ligature. It may also be used with great advantage when the blood oozes from numerous points, as in certain operations upon the vulva and other regions where ligation is impracticable. In regard to the occurrence of secondary hemorrhage the results of acupressure are highly flattering. Pirrie and Keith had, up to 1869, treated nearly one thousand vessels by this method, with less than five cases of bleeding after the withdrawal of the needle.

Acupressure may be practised according to different methods, of which, however, only four need to be here described, as they have virtually superseded all the rest. Of these some originated with Simpson himself; the others mainly with Knowles, Keith, and Pirrie, of Aberdeen, the latter of whom has greatly simplified the operation, and devised convenient names for the designation of its principal methods.

A formal description of acupressure pins and needles is unnecessary, as they may readily be obtained at any of our cutlers. They must, of course, vary in size and shape, according to the object in view, and be sufficiently strong to prevent bending, perfectly smooth, sharp-pointed, and coated with silver, nickel, or gold, although this is not absolutely essential. When such instruments are not at hand, convenient substitutes will be found in long shawl pins. Flexible steel wire is required only in one of the present methods of acupressure.

No special isolation of the artery is required, as when the ligature is used, and any bleeding veins may, if necessary, be very properly included along with that vessel without detriment. Occlusion is effected by fibrinous plugs, as in ordinary ligation, but, owing to the preservation of the vitality of the coats of the vessels, they are much more rapidly organized, and, consequently, less liable to lose their hold after the removal of the pin.

In the original operation of Simpson, the pin, previously oiled, is passed from without inwards through the skin, and thence on through the muscles and other structures down to, and underneath, the artery, in such manner as to obliterate completely its caliber by bringing together its opposite surfaces. The instrument is then pushed through the tissues on the other side from within outwards, so that, when the transmission is effected, the extremities shall rest upon the skin, while the middle firmly embraces the

Fig. 288.
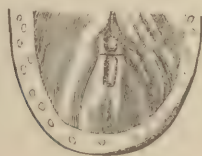
Position of the Artery and Pin in
Acupressure.

Fig. 289.
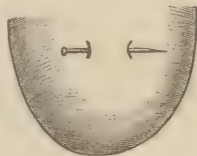
Acupressure, showing the manner in which the Ends
of the Pin project across the Skin.

artery. If the constriction is not sufficient to arrest the flow of blood, a ligature may be thrown tightly around the pin, as in the operation for harelip; but this will seldom be necessary, especially if the precaution be taken of inserting the compressor close to

the vessel, at a rather acute angle. The point of compression for the larger arteries should be at least six lines from the open orifice, and about half that distance for those of smaller size. The pin should be left entirely free during the application of the dressings, and in withdrawing it the parts must be well supported in order to avoid the risk of hemorrhage.

The annexed sketches show, at a glance, this method of acupressure. Fig. 288 displays the manner in which the instrument embraces and constricts the artery, while fig. 289 exhibits the extremities of the pin as they project through the skin. A good idea of it may also be formed by the manner in which the stalk of a flower is fastened to the lapel of a coat by transfixing the cloth with a pin.

In circumclusion, as it is called by Pirrie, the pin or needle, armed with a twisted wire, is passed completely under the vessel, which is then pressed firmly against it by means of a loop of wire hooked over its point, while the ends are fixed by a single twist around the pin, as in fig. 290.

In a torsoclusion, formerly described as the Aberdeen method, the pin is inserted into the tissues close to and parallel with the bleeding artery, and its point caused to emerge at a distance of several lines, as in fig. 291. The second step consists in giving a quarter rotation to the pin, so as to place its point above and at a right angle to the vessel; in pressing it well down, and in pushing this for some distance into the tissues beyond, so as to fix it there and maintain the twist, when the parts will present the appearance shown in fig. 292.

Fig. 290.

Circumclusion.

Retroclusion, so named because the pin is passed immediately behind the artery, consists of two steps. In the first the pin is entered a little to one side of the artery, caused

Fig. 291.
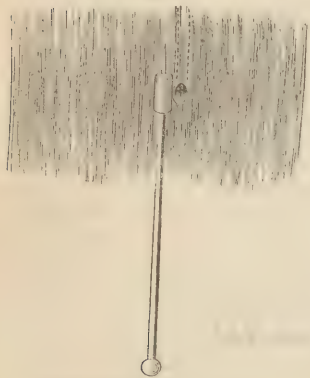
First step of Torsoclusion.

Fig. 292.
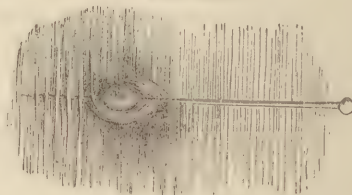
Second step of Torsoclusion.

to emerge, and passed in front and a little beyond the track of the artery, as in fig. 293. In the second step the head of the pin describes the fourth of a semicircle; its point is then sent behind the vessel, and pushed on until it is fixed in the tissues beyond, as in fig. 294.

Of all these methods of acupressure, torsoclusion deserves the preference, especially for large arteries; while retroclusion is very convenient for securing vessels of small size.

The period during which the pins should be retained must necessarily vary in different cases and under different circumstances. For a large artery, such as the femoral, a good

Fig. 293.
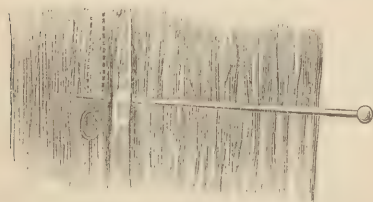
First step of Retroclusion.

Fig. 294.
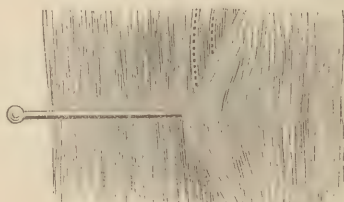
Second step of Retroclusion.

average period is from forty-eight to sixty hours; for a small one, as the ulnar or radial, from twenty-four to thirty-six. A longer time should be allowed when the patient is

restless or affected with cough, vomiting, or high constitutional excitement, or when the local action is unusually great and rapid, threatening to run into suppuration, ulceration, or gangrene. Withdrawal of the pins is effected by a gentle twist of the thumb and fore-finger, everything like rudeness being avoided, lest it should provoke hemorrhage and interfere with the adhesions of the parts.

Substitutes for the Ligature and Acupressure.—As temporary substitutes for the liga-ture and acupressure numerous instruments have been contrived, all of which possess nearly the same mode of action. Professor N. R. Smith, of Baltimore, proposed noosing the extremity of the artery with a loop of fine annealed iron wire passed through a small, double silver tube and fastened to its free extremity, which has a slit on each side for the sake of greater security. The tube is brought out at the wound, and may be safely de-tached even from a vessel as large as the femoral artery on the second day after the ope-ration. The wire, in the act of removal, is carefully unrolled, and forcibly drawn with pliers through the canula in such a manner as to sever the artery as with a small écraseur.

The late Mr. Nunneley, of Leeds, employed a pair of forceps, delineated at p. 255, fig. 72, for arresting hemorrhage. He retained the instrument, hanging out of the wound, from thirty-six to forty-eight hours, and found the method so efficacious that he rarely employed any other. Mr. B. W. Richardson, of Dublin, uses a tubular compressor, and I myself long ago recommended for stopping bleeding in deep-seated arteries a pair of light forceps with a movable handle.

The *wire loop*, as a temporary expedient for arresting hemorrhage, is a modern device, first practised, a few years ago, almost simultaneously by Dr. A. M. Pollock, of Pittsburg, and Mr. Dix, of England. It consists in encircling the artery with a thread of silver or annealed iron wire, the ends of which, brought out at the surface one-fourth of an inch apart, are twisted together or tied upon the skin, over a short cylinder of wood, gutta percha, or adhesive plaster. The procedure is applicable to vessels in their continu-ity as well as to cut vessels, and, although the artery should always be separated from its accompanying veins, no harm is likely to result if they are embraced in the same loop. The period during which the loop should be retained varies, on an average, from two to five days. If taken off too soon, secondary hemorrhage might occur ; and, on the other hand, if kept on too long, dangerous ulceration. The easiest and safest way of effecting the removal of the loop is to roll one end, after it is cut, around a pair of forceps in the direction of its concavity. When an artery is thus secured in its continuity, the ces-sation of pulsation immediately above the loop will generally serve to show that the time has arrived when it may with propriety be taken off, or, at all events, when the pressure may be safely slackened, to be again tightened if there be a recurrence of pulsation.

In an article on the wire loop, in the New York Medical Journal for July, 1869, Dr. Pollock gave an account of twenty-six amputations in which he employed this method of treatment, the number of arteries thus secured being forty-seven, including seventeen femoral. In no instance did any accident arise that was justly attributable to the pro-cedure. In one case only was there secondary hemorrhage. The average period at which the wire was removed was about five days and a half.

While the wire loop does not, apparently, possess any advantages over acupressure, ex-cept that in certain situations it is more easily applied, it is unquestionably preferable to the ordinary ligature, inasmuch as it causes less irritation, is retained only for a comparatively short time, and is more frequently followed, in open wounds, by union by the first inten-tion. The most serious objection to it is the difficulty which sometimes attends its removal.

Dr. S. F. Speir, of Brooklyn, has described in the New York Medical Record for April, 1871, a very ingenious and useful contrivance, by which arteries may be perfectly

Fig. 295.
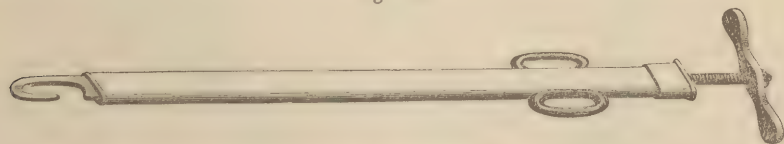
Artery Constrictor.

occluded, without any foreign material being left in the wound to interfere with its union. The instrument, delineated in fig. 295, and termed the *artery constrictor*, consists of a flat metal tube, from three to six inches in length, with a sliding steel rod, one end of

which terminates in a hook-shaped tongue, with which the vessel is constricted, while the other end has a screw arrangement, through which the tongue can be made to protrude from or retract within the sheath.   The divided artery having been brought out of the wound by a tenaculum or pair of forceps, the tongue of the constrictor is placed around, and drawn tightly upon it.   As soon as the screw meets with a considerable degree of resistance, the instrument is detached.   When the operation is properly performed, it will be found that the artery is completely occluded by the manner in which the internal and middle tunics are ruptured and invaginated, at the same time that the outer one is drawn more or less firmly over them.   The advantages of this mode of treatment are said to be its efficiency, safety, and facility of application ; and I am informed by Dr. Speir that it has been successfully employed in amputation at the hip, of the thigh, and of the leg, and applied to the carotid and femoral arteries for the cure of aneurism.

3. *Compression.*—Although ligation and acupressure are the most certain means of arresting hemorrhage, cases occur to which they are either not at all adapted, or where, from the great depth and narrowness of the wound, they are impracticable.   It is then that compression becomes available ; an agent often hardly less valuable than either of the other methods.   It is particularly serviceable when the injured vessel lies upon a bone, as in injury of the brachial and temporal arteries ; in wounds penetrating deep cavities, as the thoracic and abdominal ; and, lastly, when the blood issues from a considerable number of small vessels instead of escaping from one large one.

The compression may be temporary or permanent, according to the exigencies of the case.   Temporary compression is made with the hand, finger, tourniquet, or compress and bandage, until the injured artery can be ligated, or secured in some other effectual way.

Fig. 296.

Tourniquet applied to the Femoral Artery.

In permanent compression, the application is continued until the vessel is completely obliterated, whether the time be short or long.

Temporary compression is necessary chiefly in cases of sudden emergency, as, for example, when an individual is stabbed in the femoral artery, and the surgeon cannot obtain any assistance in tying the vessel. In such an event, an attempt is made to arrest the hemorrhage with a tourniquet, fig. 296, or with a graduated compress and bandage ; the former being placed directly over the course of the artery from which the bleeding proceeds, or, if this be impracticable, over the main trunk of the limb, and the latter directly over the wound as well as for some distance above, along the track of the vessel.   In either case, it is to be borne in mind that the compression, even if maintained only for a few hours, may become a source not only of excessive pain, but also of mortification.   The greatest possible vigilance should, therefore, be exercised in its employment.

The original idea of the tourniquet is generally ascribed to Morel, a French military surgeon, who employed it in the treatment of various kinds of wounds at the siege of Besançon, in 1674.   Hans von Gerstorff, however, had previously devised an instrument for arresting hemorrhage, and out of these crude attempts arose the beautiful and very perfect contrivance now known as the tourniquet of Petit, delineated in fig. 296.

When the ordinary tourniquet is not at hand, very efficient compression may be made by tying a piece of bandage, a cravat, or a handkerchief loosely around the limb, and then twisting it firmly over a thick compress by means of a stick, fig. 297, a cane, or the hilt of a sword, fig. 298, inserted underneath it.   This contrivance, usually called the field tourniquet, because it was originally employed on the field of battle, may advantageously be applied when a surgeon is obliged to amputate an extremity without having a sufficient number of intelligent assistants, although it labors under the inconvenience of not always concentrating the pressure upon the spot where it is most needed.   For this reason the common tourniquet is decidedly preferable.

For arresting hemorrhage in gunshot and other wounds on the field of battle, the most effective tourniquet is that of Mr. Lambert, of Peekskill, consisting of two concavo-

convex pads of tin plate, connected by a non-elastic ribbon, nearly two feet in length by an inch and a half in width. When the instrument is applied, one of the pads rests upon the main artery of the limb, and the other upon a point directly opposite, without the slightest intermediate constriction, and, consequently, without any embarrassment whatever of the venous circulation.

Fig. 297.

Field Tourniquet; Handkerchief and Stick.

Fig. 298.

Field Tourniquet; Handkerchief and Sword.

Compression with the hand, thumb, or finger may often be advantageously employed for the arrest of accidental hemorrhage, until a ligature can be applied; and it is also occasionally resorted to for the purpose of controlling the circulation in the main artery

Fig. 299.

Digital Compression of the Brachial Artery.

Fig. 300.

Digital Compression of the Femoral Artery.

of a limb during amputation. In the upper extremity it is generally applied to the brachial artery, as it courses along the inner border of the flexor muscle; and in the

lower, to the femoral artery where this vessel lies upon the pubic bone beneath Poupart's ligament. The annexed drawings, figs. 299 and 300, are illustrative of the subject.

The arteries which most readily admit of indirect temporary compression are, first, the common carotid, with some of the branches of the external carotid, as the facial, coronary, temporal, and occipital; secondly, the subclavian, axillary, brachial, radial, and ulnar; and, lastly, the iliac, femoral, and popliteal. The circulation of the abdominal aorta may be arrested in a similar manner, especially in lean subjects, as has been shown in a multitude of cases of hemorrhage of the uterus, wounds of the groin and thigh, and in amputation at the hip-joint, in the latter of which, as experience has proved, this mode of compression is of the greatest consequence as a means of preventing loss of blood.

1st. The most eligible point for compressing the common carotid is the omo-hyoid angle, between the sterno-cleido-mastoid muscle and thyroid cartilage. The vessel here is situated more superficially than lower down, and may, especially if it be pushed a little over towards the middle line, be readily forced against the bodies of the cervical vertebræ. If the finger or instrument, whatever this may be, be applied perpendicularly, or carried too far outward, there will be danger of arresting the circulation in the jugular vein, and thus causing serious cerebral disturbance, to say nothing of the injurious effects that might result from the compression of the phrenic, sympathetic, and pneumogastric nerves. In any event the operation is always painful, and can seldom be borne for any length of time. When it is obliged to be protracted, the best plan is to use alternate pressure with two fingers, applied to different portions of the vessel.

The pulsation of the facial artery may be effectually controlled by pressure made with the finger against the outer surface of the lower jaw, a little in front of the masseter muscle. The vessel is so superficial that it may always be readily found.

The coronary artery is compressed by seizing the lip with the the thumb and forefinger, or with a Nunneley's forceps, on each side of the wound, fissure, or disease, otherwise the hemorrhage will only be partially controlled, as is evinced in the operation for harelip and in the excision of carcinomatous growths.

The temporal artery is compressed in front of the ear, about two lines from the tragus, and a little above the zygomatic process. The vessel, at this point, is very superficial, and is, therefore, easily flattened against the bone, from which it is separated only by a thin layer of fibro-muscular substance. The supraorbital artery is controlled by the application of the finger immediately above the supraorbital notch, at the distance of about an inch from the root of the nose; and the occipital, in the space midway, or nearly midway, between the mastoid process and the attachment of the complexus muscle.

2dly. Compression of the subclavian artery is often required on account of wounds and operations in and upon the axilla, the lower part of the neck, and the upper part of the chest. The necessary pressure, which, however, can seldom be borne long, owing to the presence of the axillary plexus of nerves, may be made with the instrument delineated at p. 517, the thumb, or the handle of a stout, well-covered key, applied to the supraclavicular fossa, near the outer border of the sterno-mastoid muscle, the shoulder being forcibly depressed. The artery at this point lies upon the first rib, and can be easily controlled, provided the pressure be directed downwards and somewhat inwards, in the line of the bone.

The axillary artery is most effectually compressed against the head of the humerus, while the arm is extended at nearly a right angle with the trunk. The vessel, when the limb is in this position, is put considerably upon the stretch, and is thus easily maintained in contact with the bone.

Compression of the brachial artery may be effected in almost any portion of the extent of this vessel, as it courses along the biceps and coraco-brachial muscles, but cannot be maintained for any length of time on account of the pain experienced in the accompanying nerves. It is most conveniently made by grasping the limb with the thumb and fingers, the latter being applied in such a manner as to press the artery perpendicularly against the humerus. The circulation is always easily controlled by the tourniquet. Hemorrhage of the brachial artery from venesection has been temporarily arrested by flexing the forearm forcibly upon the arm. A similar procedure will stop the pulse at the wrist.

The proper place for arresting the circulation in the radial and ulnar arteries is the inferior third of the forearm, where these vessels are not only quite superficial, but where they may easily be flattened against the bones. Temporary compression may conveniently be made with the fingers; permanent, with two small compresses, confined in such a manner as not to embarrass the return of the venous blood. The arteries of the fingers

may be controlled by pressure applied at the junction of the anterior with the external surface.

3dly. The aorta in lean subjects, or even in a person of ordinary embonpoint, with empty bowels, may easily be compressed at the umbilicus against the lumbar vertebræ, either with the fingers, or, what is better, a Pancoast's tourniquet. The force should be applied a little to the left of the middle line, so as to avoid the vena cava, and the abdominal muscles should be well relaxed by the elevation of the hips and shoulders. This mode of compression is often highly serviceable in arresting uterine hemorrhage, and is now almost universally employed as a means of controlling the circulation in amputation at the hip-joint. Bleeding from a wound of the external iliac artery may also thus be commanded. In using the tourniquet, care must be taken not to bruise any of the abdominal viscera. In ordinary cases, in thin subjects with empty bowels, compression of the aorta is usually easily effected with the thumbs, or thumbs and fingers.

The circulation of the common iliac artery may be controlled by relaxing the parieties of the abdomen and making pressure against the brim of the superior strait of the pelvis. To command the external iliac, the force must be applied against the inner border of the psoas muscle. In neither of these situations, however, can compression be employed with much certainty of success; but the circulation can be effectually stopped by compressing the common iliac artery through the rectum with the hand, as suggested by Dr. Frank Woodbury, of this city, or with a lever of wood, as practised by Mr. Davy, of London.

In the lower extremity, compression of the femoral artery, at its exit from the pelvis, is almost exclusively relied upon for commanding the circulation in amputations, resections, and accidental hemorrhage. Louis was the first to substitute this method for the tourniquet in ablation of the thigh, and the practice is now very common among the best surgeons in this and other countries. One decided advantage which it possesses over the tourniquet is that it is less painful, more certain, and attended with much less venous hemorrhage. The compression is generally made with the two thumbs placed the one upon the other, just beneath Poupart's ligament, and midway between the pubic symphysis and the anterior superior spinous process of the ilium. In order that the pressure may be perpendicular, and, therefore, the more effective, it should be made, as Malgaigne has very properly remarked, rather obliquely upon the artery, upwards and backwards, forming with the horizon an angle of 45°. When the assistant is unwilling to trust himself with his thumbs or fingers, a large key, with an appropriate pad attached to the handle, may be used as a substitute.

The femoral artery in the middle third of the limb may be effectually compressed against the thigh-bone, either with the fingers grasping the limb, tourniquet, or the compressor described at p. 517.

The tourniquet is sometimes applied to the popliteal artery, opposite the knee, a tolerably thick roller, pad, or compress being placed beneath the instrument in order to render the pressure more effective. Compression with the fingers is difficult and inoperative, on account of the great depth of the vessel.

The tibial arteries can be compressed only in the lower portion of their extent, as they are there comparatively superficial, while higher up they are deeply buried among the muscles. The anterior vessel is commanded as it passes along the side and front of the bone, between the tendon of the common extensor of the foot and the proper extensor of the great toe. A tourniquet applied here, over a hollow splint, stretched along the inner and back part of the limb, as suggested by the late Dr. Alexander H. Stevens, in 1818, will readily control the circulation. The posterior tibial artery is compressed between the heel and the ankle, its pulsation serving as a guide to its situation. The dorsal artery of the foot is easily controlled, as it runs down across the instep, being covered merely by aponeurosis, connective tissue, and skin.

The *veins*, from their superficial situation and the greater softness of their tunics, are much more easily compressed than the arteries. The deep-seated ones, however, often require a good deal of force, and even then their circulation is sometimes controlled with difficulty.

The proper place for compressing the external jugular vein is about one inch above the clavicle, at the centre of this bone, in the inferior triangle of the neck, where it empties into the subclavian. The vessel runs perpendicularly across the sterno-mastoid muscle, in the direction of a line drawn from the angle of the jaw to the middle of the clavicle.

The subclavian, axillary, and brachial veins accompany the arteries of those names, and cannot be compressed independently of them, except in the case of their division.

The cephalic and basilic veins with their branches are easily commanded at the bend of the arm.

The saphenous and femoral veins are most effectually compressed in the upper portion of Scarpa's triangle, from an inch and a half to two inches below Poupart's ligament. The former vessel is superficial, and the latter lies in close contact with the inner border of the femoral artery.

In *permanent compression* the force is applied in one of two ways, either directly or indirectly. The former method is particularly adapted to the suppression of hemorrhage from deep wounds, as in the lateral operation of lithotomy; in wounds of the rectum, whether accidental or wilful; in bleeding of the nose and uterus; in the removal of tumors from the maxillary sinus; in the extraction of teeth; in the extirpation of the eye; and, finally, in wounds of the middle artery of the dura mater, as well as in a number of injuries in other regions of the body.

The great objection to this mode of compression is its liability to be deranged and to produce severe pain and inflammation, the latter of which is often sufficient to cause profuse suppuration. It should, therefore, never be employed with a view of arresting hemorrhage from a large artery, or even from a small deep-seated one, if it be practicable to apply a ligature, as this is, of course, always the most certain and efficient means; but this objection does not obtain when the blood proceeds from a bleeding cavity, or when it oozes from the bottom of a recent wound. In such a case, indeed, compression must be used at all hazard, for there is frequently no other way by which the flow can be arrested.

The compression may be made with a graduated pad and roller, or by means of sponge, cotton, wool, patent lint, or any other porous substance. Whatever article be employed, the bleeding surface must previously be freed from coagula, in order that the compress

Fig. 301.

Plan of a graduated Compress. *a.* The Artery wounded. *b, b.* The graduated Compress, arranged so that the apex of the cone is in immediate contact with the bleeding Orifice, while its Mass occupies the general Wound, and projects somewhat above the Integumental level.

may be placed directly in contact with the orifices of the vessel, as exhibited in fig. 301. When the blood proceeds from a large artery, the circulation must be controlled, during this part of the procedure, with the finger or tourniquet applied some distance above the wound. The compress is then thrust gently but firmly into the breach, the smallest piece being placed directly upon the mouth of the vessel, the next above this, and so on until a sufficient number have been applied, when the operation is completed by bandaging the limb from its distal extremity upwards, care being taken that the pressure be made in as equable and uniform a manner as possible. The part is then put at rest, in an elevated position, and action moderated by the use of cold water, anodynes, and other suitable means. The dressings are frequently examined, but not disturbed under four or five days, unless they become displaced, or offensive from the discharges.

When hemorrhage proceeds from a wound, as, for example, from that made in lithotomy, the part must be plugged with a sponge, or a piece of patent lint, the hollow of which is filled up with similar material, or raw cotton, an instrument having previously been introduced through the foreign substance to conduct off the urine. A like plan is pursued in bleeding of the rectum. In hemorrhage of the uterus, the vagina is plugged; in epistaxis, the nostrils.

In injuries of the bones, a plug of soft wood, as a piece of pine, is sometimes used. In compound fracture of the skull, attended with lesion of the middle meningeal artery, running in an osseous canal, such an expedient is often the only one which can be successfully opposed to the hemorrhage. Bleeding of the nutrient artery of the long bones is occasionally stopped in a similar manner.

In some cases the tissues of the part whence the hemorrhage proceeds are employed as the compressing agents. In the operation for harelip, for example, the simple approximation of the edges of the fissure by the twisted suture effectually arrests the flow of blood from the coronary arteries.

The compression is said to be indirect or lateral, when it is applied to the track of the injured vessel instead of to its orifice. It is generally a more eligible way of arresting hemorrhage, as it is free from the objections that have been urged against direct compression, with which, however, it is occasionally combined. The best mode of effecting it is to place a long and rather narrow compress over the course of the artery, extending from the neighborhood of the wound some distance above, and to confine it by means of a roller,

commencing at the distal portion of the limb, and carried upwards in such a manner as to afford equable support at every point. In other respects, the treatment is conducted as in direct compression. This mode of management is often employed, with the happiest effects, in wounds of the brachial artery, at the bend of the arm, caused by venesection.

Digital compression has been successfully employed in hemorrhage of wounded arteries, and is worthy of further trial. It is conducted by a relay of assistants in the same manner as in the treatment of aneurism, described in the next chapter. The procedure is particularly applicable to hemorrhage of the brachial artery.

4. *Torsion.*—Torsion of the arteries is an old procedure, mentioned by Celsus, and reintroduced to the notice of the profession by Thierry, Amussat, Velpeau, and others; at one time pointedly condemned, at another immeasurably lauded, and even now opinion is by no means settled in regard to its safety as a general hemostatic agent, although the experience of Syme, Humphry, Bryant, Hewson, Tillaux, and others goes to show that it may be confidently applied to all arteries of the extremities, healthy and diseased, and also to such arteries of the trunk as do not exceed the volume of the femoral. The operation, which answers admirably in the inferior animals, as a substitute for the ligature, is executed with two pairs of forceps, as seen in fig. 302; a

Fig. 302.
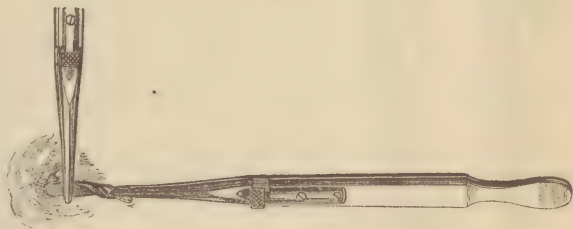
Torsion-forceps.

small one for drawing out the artery by grasping it horizontally, and a long, stout one provided with a slide and serrated blades, for twisting it in its longitudinal axis; from six to eight turns being required, according to the size of the vessel, to lacerate and bruise its tunics so as to intercept and coagulate its contents. The vessel, properly isolated, must be held firmly, and twisted sharply until all resistance is overcome. When the artery is inflamed, softened, ulcerated, or rendered fragile from fatty degeneration, the operation must be performed more cautiously, with less force, and fewer rotations. The end of the vessel must not be twisted off; and the current of blood should always be allowed to enter the tube before the forceps are removed, in order to test the completeness of the occlusion, as the safety of the procedure must necessarily depend upon the manner in which this has been effected.

When torsion is properly executed, the inner and middle coats of the artery are not only lacerated, but the resulting shreds are more or less incurvated, or bent across the caliber of the vessel in such a manner as to form almost complete valves, which, while they oppose the flow of blood, entangle the fibrin of that fluid, and thus accelerate its coagulation. The outer tunic, on the contrary, is simply twisted, not broken up, an arrangement which adds greatly to the safety of the patient.

The advantages of torsion are that it favors the repair of wounds, and lessens the danger of suppuration; its disadvantages, that it is sometimes troublesome, and that it does not always arrest bleeding. The risk of secondary hemorrhage is inconsiderable, if the operation be done with due caution.

The annexed cut, fig. 303, represents the torsion-forceps of Dr. Addinell Hewson, consisting of two sets of blades, one broad and flat, for seizing and drawing out the artery; the other, a much smaller instrument, duck-bill shaped or curved at the point, and designed for dividing the coats of the vessel. The torsion is effected by rotating the forceps upon their axis, from two to three turns being sufficient to insure the occlusion of the largest vessel by lacerating the two inner coats and bruising the outer one, these effects being highly favorable to the coagulation of the blood and to the stoppage of hemorrhage. In an artery of the size of the femoral it is proper to let the forceps hang for a few minutes after the torsion is completed; or, instead of this, another turn may be made, in order to fix the twist more securely.

Torsion, as effected with the common forceps, is represented in fig. 304, from Follin, the twist being so firm as to prevent the possibility of undoing itself.

5. *Forced Flexion.*—This mode of treatment, introduced mainly through the influence of Dr. Heath, of Newcastle-on-Tyne, although previously practised by others, as Malgaigne and Richet, is applicable exclusively to the arteries of the extremities, and commends itself by its great simplicity, the principle of treatment consisting in moderating and restraining the flow of blood by overflexion of the joints. In wounds of the arteries

Fig. 303.
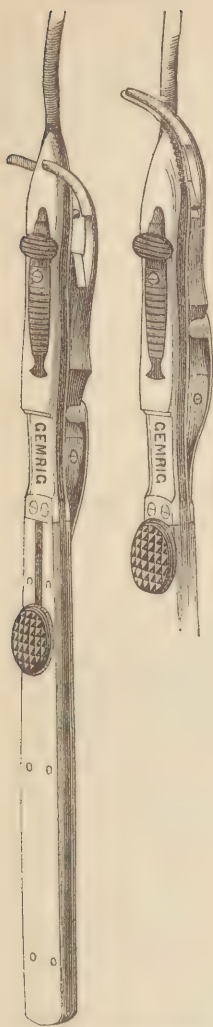
of the forearm and palmar arches, the former should be bent on the arm, the hand being pronated, and either flexed or extended at the wrist. For the arrest of hemorrhage of the lower extremity, a roll of lint, or other soft material, having been placed in the ham, the leg should be flexed on the thigh and the thigh on the abdomen, and confined by means of adhesive strips or a roller.

6. *Styptics.*—Styptics are remedies which arrest hemorrhage by their direct influence upon the blood, and the arteries furnishing it. They comprise a long and varied catalogue of articles, some of which produce merely an astringent effect; others act apparently mechanically; and others, again, are escharotic, destroying both the vessels and the connecting tissues.

The most powerful, and, at the same time, the least objectionable styptic at present known is Monsel's salt or subsulphate of iron. It is applied either in substance, or, what is preferable, in strong solution upon cotton or patent lint, and possesses the property of instantaneously coagulating the blood, converting it into a very dense, insoluble clot, which continues to increase and to harden for several hours afterwards. What adds greatly to the value of this remedy is its entire freedom from causticity and its remarkable antiseptic property. It is particularly adapted to hemorrhage of the nose, mouth, throat, and uterus, as well as of

Fig. 304.

other parts of the body where it is impossible to ligate the bleeding vessels, on account of the great depth at which they are situated. One part of the officinal solution diluted with from four to six times that quantity of water is an efficient hemostatic for ordinary purposes. The wound, well wiped as a preliminary measure, is covered with a thick compress wet with the fluid, and confined by a suitable bandage. Lint, thoroughly saturated with a solution of the salt, and then dried and rolled up makes an excellent extemporaneous styptic.

Among the minor and less reliable styptics are alum, sulphate of copper, creasote, and matico. Of these, the first is by far the most valuable. It may be applied in saturated solution, or in powder, upon patent lint, directly to the bleeding surface, previously freed of clots, and generally produces a powerful astringent effect, causing speedy coagulation of the blood, and marked

Hewson's Torsion-forceps.   Mode of applying Torsion.

contraction of the vessels, without necessarily provoking suppuration. Sulphate of copper may be used in a similar manner, or in the form of a stick, held firmly for some minutes upon the oozing capillaries. Creasote and matico possess none of the hemostatic qualities formerly ascribed to them, and are now never applied with such a view.

Pagliari's styptic consists of a strong watery solution of benzoin and alum, which causes instantaneous coagulation of the blood. The clot, however, is less firm than that produced by subsulphate of iron, and I have myself very little confidence in its efficiency as a hemostatic, except in hemorrhage from very small vessels, in which it sometimes answers exceedingly well. A good styptic, often used with great advantage by the late Professor Pancoast, especially in the milder forms of hemorrhage, is composed of one drachm of Venetian soap and twice that quantity of carbonate of potassium dissolved in three ounces of alcohol. Hemorrhage of some of the internal cavities, especially of the uterus, consequent upon the presence of fibrous tumors, is often promptly arrested by the injection of a solution of one drachm of iodine and twice that quantity of iodide of potassium in two ounces of alcohol and four ounces of water. Alcohol alone is not a bad styptic in an oozing wound; it seems to do good by coagulating the albuminoid principles of the blood.

Cold is a powerful styptic, and may be used in various ways. A current of cold air

will often promptly and effectually arrest capillary hemorrhage, or even hemorrhage caused by the division of a small artery, as is exemplified in operations upon the tonsils and anus, or ano-rectal region, as well as upon other parts of the body. To prove beneficial, the air must have free access to the part, and hence it may often be usefully directed by means of the fan, which has the additional advantage of rendering it more cool.

Cold water, refrigerating lotions, pounded ice in bladders, or lumps of ice rolled up in cloths, applied to the bleeding surface or in its immediate vicinity, occasionally promptly arrest hemorrhage. These applications are particularly valuable in deep-seated hemorrhage, or in hemorrhage of the internal organs and cavities; they must, however, be used with a certain degree of caution, as their protracted continuance may be followed by injurious reaction, and even by mortification of the part. When the wound is situated externally, but too deeply to render the injured vessels accessible to the ligature, the bleeding may often be speedily and effectually checked by a full stream of iced water, directed upon the part, and maintained steadily for some time, from a large syringe.

Hot water has lately been found very efficacious in arresting the oozing from wounds, as after amputations, excisions, and the extirpation of tumors. Its beneficial effects are doubtless due to its coagulating effect upon the albumen of the blood, and to its producing contraction of the vessels. It should be applied as hot as can be borne by means of a soft sponge.

The actual cautery can hardly be considered as a genuine styptic, although it is usually classed under this head. Its effect is not to constringe the vessels, but to destroy them, by producing an eschar, by which their mouths are, for the time, hermetically sealed. Upon the separation of the slough, however, there is frequently a recurrence of the hemorrhage, especially if the wounded vessels are at all large, owing to the imperfect coagulation of their contents. The cases to which the cautery is mainly applicable are those in which the hemorrhage proceeds from a deep and narrow osseous cavity, and in wounds of the tonsils, uterus, and rectum. The instrument, which may be of a conical form, should be heated to a black or slightly red heat, and used in such a manner as not to injure the structures around the seat of the affected vessels. When the artery is very diminutive, the object may sometimes be attained with a hot knitting-needle, a wire, or a probe.

General Means.—Whatever mode of procedure be adopted for arresting the bleeding, it is an object of primary importance to place the affected part perfectly at rest, in an easy and elevated position; the slightest motion might be injurious, especially when no ligature has been used, and should, therefore, be sedulously guarded against. Repose of the body is equally necessary with that of the part, and it is hardly needful to add that mental tranquillity is also of the greatest moment. Cardiac action, too, must be maintained in the most perfect quietude, as any perturbating agency of this kind cannot fail to favor a return of the hemorrhage and exhaust the system. With this view, a full anodyne should be administered early in the disease, the dose being repeated from time to time so as to sustain the soothing influence of the remedy. Too much stress cannot be laid upon the use of opiates in the management of arterial hemorrhage, and it is surprising that the remedy is not more generally employed than it seems to be. To allow the heart to go riot, or to move and toss about tumultuously, as it is so liable to do after serious loss of blood, while every local precaution is taken for the suppression of the bleeding, is assuredly a strange inconsistency, and one altogether irreconcilable with experience and common sense. When the bleeding proceeds from a great number of small vessels, a restraining influence may be expected from the administration of ergot in full and repeated doses.

When high constitutional excitement exists, the effect of the anodyne should be aided by the judicious use of aconite or veratrum viride. When the skin is very hot and dry, a full dose of Dover's powder often answers an excellent purpose in calming the heart's action.

The diet should be perfectly bland, and sufficient in quantity to supply the wants of the body. To give less, might cause irritability of the system; to give more, overstimulation. The drink must be cold and acidulated, and not taken so freely as to oppress the stomach, as it will be sure to do if the quantity is not carefully restricted, as the thirst is always urgent after the loss even of a comparatively small amount of blood. Lumps of ice, or pounded ice, held in the mouth, and gradually swallowed, often prove most grateful and beneficial. The air of the apartment must be kept perfectly cool; in short, every effort must be made to maintain the tranquillity of the circulation.

Secondary Hemorrhage.—Secondary hemorrhage occurs at variable periods; sometimes in a few hours, at other times not under several days or weeks. It is not necessarily preceded by primary hemorrhage, but may come on where the loss of blood in the first instance was, perhaps, altogether insignificant, and where everything, so far as this event is concerned, gave promise of a most favorable issue. The bleeding often supervenes without any assignable cause, generally suddenly and unexpectedly; hence it often makes great progress before an opportunity is afforded to arrest it. When proceeding from a large vessel, it may prove fatal in a few minutes, in the same manner as when the bleeding is primary. The scarlet hue of the blood always denotes its source.

The causes of secondary hemorrhage are various, but the most important are the following:—1st. The faulty application of the ligature; 2d. A diseased state of the arteries; 3d. Morbid changes in the clot; 4th. Improper traction upon the ligature; 5th. Tight dressing, or too great dependency of the part; 6th. Want of retraction in the vessels; 7th. Organic lesion of the liver, heart, and other viscera; 8th, scurvy; and, 9th, a hemorrhagic diathesis.

1. When a ligature is properly applied, it simply divides the inner and middle tunics, leaving the outer intact; this too, however may be cut, not completely, but partially, and, therefore, the more insidiously, in consequence of the force used in tying the ligature; or, the deligation may not have been sufficiently firm, the opposite surfaces being only slightly approximated, and the resulting adhesion, therefore, inadequate to effect hermetic closure of the artery on detachment of the cord; or, lastly, the fault may have existed in the ligature itself, on account of the rottenness of its substance, or the imperfect tightening of the knot. Whatever the cause may be, the proper remedy is more efficient ligation.

2. The hemorrhage may arise from disease of the *artery*, either from undue inflammation, or degeneration of its coats, rendering them incapable of supporting the ligature until the clot has contracted sufficiently firm adhesions. The mode of procedure is obvious; a more healthy portion of the vessel must be sought for, and the ligation effected with more caution; or, this failing, the hemorrhage may be arrested by tying the main trunk of the limb, some distance from the seat of the injury. If both these expedients prove unavailing, or if their employment be deemed inadvisable, an attempt should be made to arrest the bleeding by means of styptics, either alone, or in union with a graduated compress and roller. Experience has shown that this method is often far preferable to the ligature, which, under such circumstances, seldom maintains its hold upon the vessel until a sufficient amount of repair has been set up to prevent a recurrence of the hemorrhage.

Fig. 305.

Partial Absorption of the Clot in the Femoral Artery, a Fortnight after Amputation.

3. Morbid changes in the *clot*, commencing in a process of softening and disintegration, occasionally occur after ligation, leading to its premature detachment, perhaps several weeks after the operation. Such changes, which are well illustrated in fig. 305, are most frequent in cases of pyemia and diffused erysipelas, consequent upon some injuries and amputations, eventuating in a tendency to suppurative inflammation. The only remedy is the ligation of a healthy portion of the artery; or, when this is impracticable, the employment of acupressure or the application of styptics and the graduated compress.

4. Surgeons sometimes bring on hemorrhage by improper traction of the *ligature*, with a view of promoting its separation, forgetting that they may thus tear the artery, or break up important adhesions. Such a procedure cannot, as stated elsewhere, be too severely censured. Religation is obviously the remedy in such a case.

5. *Tight dressing*, causing unequal constriction of the part, or improper dependency, favoring undue afflux of blood, may induce this form of hemorrhage. The result will be most likely to occur when a number of small arteries have been divided, without any attempt having been made to secure them with a ligature. Bleeding having ceased, the dressings are applied, but too firmly, or the part is placed too low, and presently blood begins to appear, issuing, perhaps, with great freedom. The treatment consists in the removal and readjustment of the dressing, with strict attention to posture.

6. Secondary hemorrhage occasionally comes on after operations for the relief of anal, perineal, and other fistules, chronic abscesses, and old ulcers, from an inability of the vessels to *retract* in consequence of the indurated condition of the divided

parts. Exposure of the surface to cold air, the application of ice, direct compression, or styptics constitute the best means of relief. In some cases the actual cautery may be required.

7. Organic disease of some of the principal viscera, especially of the liver, heart, and spleen, often favors secondary hemorrhage after injuries and operations. Indeed, spontaneous hemorrhage is by no means uncommon under such circumstances, and it is, therefore, not surprising that it should occasionally occur after accidents and the employment of the knife.

8. *Scurvy* is a powerful predisposing cause of secondary hemorrhage. The blood in this condition of the system is, in great degree, deprived of its coagulability, and hence the clot that forms above the seat of the wound is easily disintegrated and washed away. The coats of the vessel are also softened and diseased, and, therefore, ill able to bear for any length of time the pressure of the ligature, which is generally detached at a period varying from the fifth to the eighth day, before the clot has had time to become firmly adherent to the sides of the affected artery. The most effectual means of counteracting this condition of the system are fresh air, tonics, stimulants, anodynes, vegetable acids, and other antiscorbutic remedies.

9. The bleeding may be due to a *hemorrhagic diathesis*, an affection which, as will be stated elsewhere, may occur at any period of life, and which it is often extremely difficult to control by any mode of treatment, however judiciously conducted.

Finally, this form of hemorrhage is sometimes brought on by *injuries* inflicted in the transportation of the patient, as in time of war and after severe operations, lacerated wounds, and compound fractures. The clot, if not firmly adherent, is easily detached from the jolting of the affected artery and the cardiac excitement consequent upon the disturbance of the part and system. Excessive mental perturbation is capable of producing similar effects, especially when a vessel, previously partially occluded by a clot, has not been properly ligated.

SECT. II.—SUBCUTANEOUS HEMORRHAGE.

There is a form of arterial hemorrhage to which, from its situation, the term subcutaneous is very properly applicable. It takes place when, from any cause, an artery has been laid freely open, and its contents, instead of escaping externally, are extensively extravasated among the surrounding structures. In ordinary hemorrhage, the blood issues directly from the injured vessel, because the outer wound is sufficiently capacious to admit of its free and unrestrained passage, and the consequence, generally, is that it continues until the patient faints, and the bleeding orifice is closed by coagula. In the variety of hemorrhage, however, under consideration, the opening in the integument is so small as to prevent the blood from appearing externally, and it, therefore, accumulates beneath the skin, in the subcutaneous connective tissue when the artery lies superficially, or in the subcutaneous and intermuscular connective tissue when it is deep-seated. The accident which usually causes this hemorrhage is a puncture, such as that inflicted in venesection at the bend of the arm, where, in civil practice, it is most commonly met with. It may, however, in consequence of a stab, the thrust of a bayonet, a gunshot wound, or the laceration occasioned by the sharp end of a broken bone, occur in any part of the body.

The smaller as well as the larger arteries are sometimes ruptured by the passage of the wheel of a carriage, by falls, blows, kicks, and other external injury. The subclavian and axillary arteries have occasionally been lacerated in the attempts to reduce an ancient dislocation of the shoulder-joint. Spontaneous rupture not unfrequently occurs, especially in the arteries of old subjects, in consequence of the degeneration of their tunics, by which they are rendered so brittle as to be incapable of resisting the pressure of the current of the blood. In general, however, the rupture thus induced is partial, or limited to the internal and middle membranes.

The hemorrhage may be very slight, or exceedingly profuse, its extent being regulated chiefly by the size of the affected vessel, and the quantity and laxity of the connective tissue. In the superior extremity, the extravasated fluid often reaches nearly as high up, on the one hand, as the axilla, and, on the other, as low down as the inferior third of the forearm, extensively separating the muscles from each other by breaking up their attachments, and forming a large, ill-shaped, and confused swelling, attended, especially when inflammation sets in, with violent pain, numbness, and œdema of the whole limb, and discoloration of the integument. More or less pulsation is generally present, espe-

cially in the earlier stages of the case, and, upon applying the ear over the site of the wound, a well-marked bruit may frequently be recognized, attended, occasionally, with a peculiar thrill, or a whirring noise, and a vibratory sensation. It is for these reasons that this affection has usually been described as a variety of aneurism: and, as the blood is always widely extravasated, the prefix "diffuse" is commonly added to that term, as particularly expressive of its more important attributes. Strictly speaking, however, there is no aneurism here; there is simply a subcutaneous accumulation of blood, the consequence of external injury, without any dilatation of the vessel, or degeneration of its tunics; and, although there frequently is, as just stated, more or less concomitant pulsation in the part, yet this does not any more entitle it to be regarded as an aneurism than it would be if the effused fluid were so much pus or serum.

The blood that is extravasated in this accident usually promptly coagulates, and exerting injurious compression upon the parts with which it is in contact, soon excites severe inflammation, which, especially in persons of an irritable constitution, is liable to assume an erysipelatous character, and to terminate in suppuration, ulceration, and even gangrene. The pain is often intense, depriving the patient of appetite and sleep, and making rapid inroads upon the system. I have witnessed cases in which, from the excessive distress thus produced, hectic fever soon came on, and life was placed in imminent peril.

The *treatment* of this lesion is precisely similar to that which is necessary when there is an open wound; that is, the artery must be secured promptly and at all hazard, and the coagulated blood thoroughly evacuated. The operation is often one of great embarrassment, owing to the confused and displaced condition of the parts, and the difficulty experienced in finding the injured vessel, which is not unfrequently lost in the midst of the coagulated blood. A large incision is generally required, and two ligatures must be applied, one above and the other below the wound in the vessel, precisely as in ordinary cases, the object being the prevention of hemorrhage by the recurrent circulation. As a preliminary step, the injured artery is compressed by the finger or tourniquet, or, if seated in an extremity, controlled by the elastic bandage, and, after the operation is over, the limb is wrapped up in warm water-dressing, medicated with laudanum and acetate of lead, or laudanum and alcohol, to favor the reduction of inflammation.

SECT. III.—COLLATERAL CIRCULATION.

Among the more interesting phenomena that occur after the deligation of the larger arteries, not the least curious and important is the manner in which the circulation is carried on and maintained in the structures beyond the seat of the ligature. A long time elapsed after the discovery of the ligature before surgeons could be induced to believe that such an operation could be performed in the continuity of a limb without endangering the parts below by gangrene, in consequence of the sudden abstraction of their accustomed supply of blood. Chance gradually led to the correction of this apprehension, which, however, is not without some foundation, as is proved by the fact that the procedure is occasionally followed, even at the present day, in the hands of the most scientific surgeons, by loss of limb and life. Cases had been observed, from time to time, of the obliteration of the largest arterial trunks by fibrinous concretions, and yet it was perfectly certain that the structures in the distal portions of the extremity had retained their normal growth, no difference being discoverable between them and those of the opposite side. Such a result, it was obvious, could only have been brought about by an enlargement of the collateral vessels, thus enabling them to keep up the normal supply of blood, after the obstruction of the main artery. A number of instances had been noticed of complete closure of the aorta, both in its thoracic and abdominal divisions, without any apparent detriment of any kind, either proximate or remote. These facts, the fruits of the cultivation of morbid anatomy, were eminently suggestive, and we accordingly find that they gradually paved the way for some of the most daring feats in surgery. The original trials with the ligature upon the principal arteries in the continuity of the limbs were highly gratifying, as tending to show that, although the distal structures were temporarily deprived of their accustomed supply of blood, this occurrence did not sufficiently interfere with their vitality to cause gangrene, the circulation being speedily reëstablished through the collateral routes. The process employed by nature in effecting this object has been demonstrated, in repeated instances, by dissection of the parts at variable periods after they had been subjected to operation.

The moment a large artery, as, for example, the femoral, is tied, the blood is obliged to seek new channels for its transmission to the distal portion of the limb. For this pur-

pose it passes on in all directions, entering every vessel, both large and small, into which it can find access. This, however, does not occur all at once, but gradually; for as the arteries which are to carry on this collateral circulation, as this arrangement is termed, are comparatively small, some time is necessary to prepare them for the reception and accommodation of the increased flow of blood. In fact, they are compelled to submit to a species of preliminary dilatation, their tonicity being such as rather to resent its encroachment than to yield to its effects. This is the case both with the branches that are detached from the sides of the vessel above the seat of the ligature, and with the capillaries of the various tissues entering into the composition of the limb, which, immediately after such an event, always play an important part in maintaining the distal circulation. Hence, for some time after the operation, the quantity of blood below the point of obstruction is necessarily considerably less than in the normal state, as is demonstrated by the cold and pallid state of the integument, the defective sensibility, and the loss of muscular power, which is occasionally so great as to deprive the patient of motion in the affected member. The diminution of temperature is liable to a good deal of variation, but, in general, it amounts to several degrees, and the surgeon is, therefore, often obliged to employ artificial heat. Gradually, however, as the circulation increases in vigor, the temperature returns to the natural standard, and in many cases even exceeds it, owing to the enlargement and inordinate activity of the cutaneous capillaries, although such an occurrence is usually of short duration.

An instance occasionally occurs in which there is either no change of temperature at all from this cause, or where it is so very slight as to be hardly perceptible. Such a phenomenon is most apt to happen in old aneurisms, where, owing to the obstruction in the artery connected with the tumor, the anastomosing vessels have had time to become enlarged prior to the application of the ligature, so that the operation exerts little, if any, influence upon the circulation in the distal portion of the limb, as it necessarily must in recent cases of that disease, and also in wounds of the arteries, in which no such opportunity is afforded for an increase in the size of the collateral channels.

Coincident with this effort on the part of the affected structures to establish the collateral circulation, there is generally a feeling of uneasiness, if not of actual pain, of a burning or tingling character, obviously occasioned by the compression which the enlarged and distended vessels exert upon the neighboring nerves. Usually, however, this effect is of short duration, as the nerves soon accommodate themselves to their new relations. After some time, the parts gradually recover their natural functions, all disagreeable sensations vanish, the muscles increase in vigor, and the process of nutrition proceeds apparently as well as it did prior to the deligation of the vessel.

Although such is the ordinary course of events after the main artery of a limb has been tied, important exceptions are occasionally met with. Thus, it now and then happens that the circulation remains extremely languid for an unusual length of time, perhaps for a number of days, if not several weeks, the anastomosing branches being seemingly incapable of enlarging to a sufficient extent to convey an adequate supply of blood to the affected structures; the extremity is, consequently, cold, heavy, numb, and of a reddish or purplish hue, from passive congestion of the capillaries, and is moved with pain and difficulty. A struggle is evidently going on between nature and disease, in which the latter but too often comes off victoriously; the limb either falling into gangrene without the occurrence of reaction; or, reaction taking place, it is overpowered by the resulting inflammation. Finally, cases occur, although, fortunately, very unfrequently, in which the parts remain permanently weak and crippled; the muscles are soft and flaccid, the adipose tissue is absorbed, and the surface is habitually cold and congested, the circulation having never attained the normal standard after the operation.

It is worthy of notice that gangrene, from defective circulation, is much less liable to occur after the ligation of an artery, in the continuity of a limb, in wounds than in aneurism. This fact, at all events, is clearly deducible from the statistical tables of Dr. Norris, from which it appears that in seventeen cases in which the femoral artery was secured on account of recent injuries and different tumors, gangrene did not occur in a single one, whereas this result was witnessed in thirty-one cases out of two hundred and four in which the operation was performed for the cure of aneurism. May not the cause of this disparity be the compression which the tumor in this disease exerts upon the neighboring structures, thereby obstructing the circulation in the distal portion of the limb, and at the same time seriously embarrassing the functions of the nerves? I presume that this result is very materially influenced by the nature of the wound, necessitating the deligation of the artery. If, for example, the parts are extensively divided transversely, or very

obliquely, so as to destroy the continuity of a large number of its more important branches in the immediate vicinity of the wound, gangrene will be much more likely to occur than under opposite circumstances, in which, the neighboring vessels being but little injured, the blood will easily find its way into the distal structures, thus affording them the requisite supply not only for the preservation of their vitality, but also for the maintenance of their nutrition.

Although the capillaries are greatly instrumental in carrying on the circulation in the distal portion of the limb, immediately after the deligation of its main artery, their agency is really merely of a temporary character, ceasing with the establishment of the collateral circulation, properly so called, as developed by the larger arterial branches in the vicinity of the ligature. These arterial branches are occasionally given off by the affected artery itself, but most commonly they arise from some neighboring trunks. Thus, when the superficial femoral is tied high up, the collateral circulation is established through the agency mainly of the profunda, the branches of which inosculate with the articular, offsets of the popliteal. In ligation of the brachial, the blood is transmitted to the forearm and hand by the communications naturally existing between the anastomotic and profunda arteries, branches of the affected vessel, and the recurrent branches of the radial and ulnar, in which the brachial terminates. In ligation, on the contrary, of the common carotid, the circulation of the corresponding side of the head and neck is kept up mainly by the communications between the occipital and deep cervical arteries.

It has been noticed, as an interesting physiological fact, that the anastomotic arteries, before they unite with each other, separate into several branches, often as many as three or four, so as to form a kind of circle, as if nature were particularly anxious to guard against any risk that might otherwise occur to the collateral circulation from accident or disease. It has also been noticed, especially by Porta and Stilling, that, when the fibrous structure which connects the two ends of the artery after the detachment of the ligature is unusually short and thick, a narrow, tortuous canal is occasionally developed in its interior, admitting of the passage of blood to the distal portion of the vessel.

However established, the collateral vessels gradually augment in size, until, at length, their united capacity is fully equal to that of the obliterated trunk, as in fig. 306, whatever may have been its size. There are, of course, as already stated, exceptions, but they are, probably, much less frequent than is generally imagined. A very interesting case, beautifully illustrative of the present topic, occurred in the practice of the late Dr. Francis West, of this city, in a stout, athletic man, aged thirty-two, who died suddenly from rupture of an aneurism of the thoracic aorta. On dissection, this vessel was found to be entirely obliterated, just beyond the remains of the arterial duct, its coats having a constricted appearance, as if they had been embraced by a tightly-drawn ligature. Everywhere else, excepting at the place of aneurism, the aorta was perfectly natural. All the branches of the subclavian arteries were much increased in size; and the internal mammary and epigastric, which served to keep up the connection of the circulation above and below the seat of the stricture, were fully as large as the external iliac, the former having coursed along the walls of the chest in a very tortuous manner. As no tumor was discovered at the seat of the obliteration, it could not be determined whether the disease had been the result of accident or of a congenital vice. Be this as it may, the case affords an admirable example of the manner in which the collateral circulation is carried on after the interruption of the column of blood in such an immense vessel as the aorta.

The collateral circulation is not developed with equal facility at all periods of life, or under all circumstances; it is most readily established in young subjects, in whom the arteries, besides being very active, enjoy a high degree of elasticity and pliancy, well adapted for such an enterprise. In old persons, on the contrary, the functional activity of these vessels is often much impaired, many of the small branches are obliterated, and their coats are extremely liable to earthy deposits, converting them into firm, rigid tubes, ill qualified for the discharge of their duties. In many cases, loss of blood, ill-health, or

Fig. 306.

Collateral Circulation shown in the Thigh. At *a*, the Femoral Artery has been Obliterated by Ligature.

defective vital power, seriously interferes with the development of the collateral circulation.

Finally, the collateral circulation may be too active. Such an event is not likely to happen when the main artery of a limb is tied on account of hemorrhage from a wound, but its occurrence is by no means uncommon in aneurism, and is then apt to be followed by a return of the circulation and pulsation in the tumor, in consequence of the activity of the anastomosing branches, which thus continue to feed the sac, and perhaps effectually oppose the cure.

SECT. IV.—HEMORRHAGIC DIATHESIS.

Hæmophilia, or the hemorrhagic diathesis, is that peculiar state of the system in which, generally from some slight traumatic cause, there is a strong tendency to inordinate bleeding. Persons laboring under this constitutional infirmity are often placed in imminent jeopardy by the most insignificant scratch, puncture, or incision, which, under ordinary circumstances, would hardly emit more than a few drops of blood. Occasionally the cause of the bleeding is the accidental rupture of some of the smaller vessels of the mucous membrane of the nose, lungs, rectum, or urinary bladder. The extraction of a tooth is sometimes followed by this form of hemorrhage. I recollect one case in which death was thus produced; and another where the bleeding, having persisted for nearly four days, gave rise to severe exhaustion and great apprehension respecting the safety of the patient. Many years ago I lost a child, six months old, affected with cholera morbus, from hemorrhage consequent upon lancing of the gums over the upper central incisors, which were nearly ready to protrude. His health previously to this attack had always been excellent. The bleeding commenced in less than twenty-four hours after the operation, and continued, despite all that could be done for his relief, until the end of the fifth day, when he died completely exhausted. A short time before he expired, hemorrhagic spots appeared on different parts of the body, and blood began to be discharged from the bowels. In a case of strabismus, in a young gentleman who possessed this peculiarity, the division of the internal straight muscle was followed by an oozing of blood, which continued, despite all I could do, nearly constantly, for the greater part of a fortnight, when, the wound being almost healed, it ceased. In a case reported to the Academy of Surgery of Philadelphia, in 1881, by Dr. John H. Packard, an infant, a fortnight old, died of hemorrhage from a slight scratch of the lip.

The blood in this variety of hemorrhage oozes from the injured part, as water from a sponge; it does not spirt in jets, as when it issues from an artery, or in a continuous stream, as when it flows from a vein. Its color is neither scarlet nor black, but intermediate between the two; it generally partially coagulates when it is received into a vessel, but rarely while it is in contact with the living surface.

This affection has occasionally been noticed in several members of the same family. In a remarkable case, reported by the late Dr. John A. Swett, of New York, it existed in all the children, eighteen in number. All, except one, had died from this cause, and he was suffering under profuse hemorrhage of the nose and rectum. Twelve sisters died before the age of twelve from bleeding of the uterus; and two of the brothers had fallen victims of traumatic hemorrhage.

Mr. Wardrop has reported a curious case in which this peculiarity was hereditary. The patient was a boy, in whom the hemorrhagic tendency displayed itself when he was scarcely two months old. On several occasions he nearly lost his life from the most insignificant wounds. His brother, twenty-two years old, was frequently afflicted in a similar manner. Of his five uncles, not one was free from this predisposition, three having died from the division of the frenum of the tongue, and one from the extraction of a tooth; while the other, although he suffered from the same disease, finally died from some other cause. His two aunts exhibited no signs of this diathesis; but all the male branches of their families, excepting one, were thus affected.

A still more remarkable case has been described by Dr. Hughes, of Kentucky. The predisposition here was associated with the rheumatic diathesis, and was satisfactorily traced as far back as five generations. It was confined exclusively to the male branches of the different families; but the females, nevertheless, invariably transmitted it to their offspring. Many of the individuals died in infancy and childhood, death resulting, in some, from the cut of the lancet; in some, from accidental wounds; in some, from internal hemorrhage; and, in two, simply from the application of blisters, the vesicles being filled with blood instead of water.

Of the remote causes of the hemorrhagic diathesis nothing is known. Whatever they may be, it is evident that they are deeply engrafted in the constitution, as is proved by the fact, first, that the affection generally shows itself at a very early age ; secondly, that it often occurs in several members of the same family ; and, thirdly, that it is sometimes hereditary. The immediate causes seem to be two, want of coagulability in the fibrin of the blood, and an imperfectly organized state of the capillary vessels, the actual seat of the hemorrhage.

If one were inclined to speculate in regard to the cause of this defective coagulating property of the blood, it would be easy to find it in an insufficient supply of nervous power, upon the presence of which, as is well known, the vitality of this fluid essentially depends. Whatever has the effect of weakening this influence, proportionately interferes with the concretion of the blood, both as it circulates through the body and after its removal by venesection. The fact that the blood remains fluid in sudden death from lightning has long been familiar to practitioners. Similar phenomena occur when a person is killed by a blow on the stomach, by prussic acid, the poison of the rattlesnake, excessive bodily fatigue, or violent agitation of the mind. Certain diseases, as Asiatic cholera, plague, and malignant fevers, produce analogous effects. It has been satisfactorily ascertained that, when the pneumogastric nerves are tied in animals, the blood loses its property of coagulating, the coloring matter at the same time separating from the fibrin, and assuming an unusually black color.

But as, in all these cases, the loss of nervous power is sudden, it is easy to perceive how it should influence the coagulation of the blood. In persons laboring under the hemorrhagic diathesis, on the contrary, the blood is generally habitually indisposed to coagulate, so that they are more or less liable to bleeding whenever any injury, however slight, is experienced. The analogy, then, between these different states of the system is exceedingly remote, and can, indeed, hardly be said to be established. Its force, moreover, is weakened by the fact that the subjects of the hemorrhagic diathesis generally enjoy as good health, and as much vigor of constitution, as those who are free from it. The other appreciable element in the pathology of the hemorrhagic diathesis is a want of contractility in the capillary vessels, dependent, in all probability, upon some defective organization and an absence of native tone in the muscular tunic.

The prognosis of this form of hemorrhage is generally not very favorable, particularly when it is of a hereditary nature, in which event it is extremely liable to prove fatal. In the case related by Swett, seventeen out of eighteen members of a family thus affected had perished, and the survivor himself had repeatedly suffered from severe bleeding in different parts of the body. In the case of Hughes, in which the diathesis prevailed in not less than five generations, nearly every individual died from hemorrhage ; many of them in infancy and childhood.

In the *treatment* of the hemorrhagic diathesis, the two leading indications are to promote the coagulability of the blood, and to increase the contractility of the capillary vessels.

The first of these objects is best fulfilled by the judicious use of acetate of lead and opium, the former of which seems to exert a direct influence upon the coagulability of the blood, while the latter affords important aid in controlling the action of the heart, generally rendered turbulent by the bleeding and by the patient's mental anxiety. The dose of the salt should vary from half a grain to a grain and a half, every two, three, or four hours, according to the tolerance of the stomach and the amount of hemorrhage, and should contain at least one grain of opium, or its equivalent of acetate of morphia. If heat and dryness of skin exist, a small quantity of antimony or ipecacuanha may be added to each dose, to promote perspiration. Severe depression, however, must be vigilantly guarded against. Cardiac action is controlled by tincture of aconite or veratrum viride, its effects upon the system being carefully watched.

To increase the contractility of the capillary vessels, ergot must be freely employed, in union with tonics, as tannate of iron and quinine, and a nutritious diet. Dilute sulphuric acid, in doses of eight or ten drops, repeated four or five times a day, is often highly beneficial. The diet should be light and non-stimulant, consisting largely of milk and beef essence, along with more or less alcohol. Tranquillity of mind and body is of paramount importance.

Laxatives usually prove highly serviceable, both as evacuants, as counterirritants, and as restorers of the secretions, which are nearly always much disordered in this variety of hemorrhage. Estimating these remedies at their real value, I am satisfied that they are entitled to the highest rank in the treatment of this affection ; they must not, however,

be carried too far, otherwise they may induce irritability of the heart, and thus do harm instead of good. If the patient is plethoric, sulphate of magnesium may be taken, as it is particularly appropriate, under such circumstances, on account of its chemical action upon the blood; or, what will generally be better, especially when there is marked derangement of the secretions, a few grains of calomel and compound extract of colocynth.

When the bleeding is attended with fever, or with heat and dryness of the surface, diaphoretics, as antimony and morphia, or the neutral mixture, aided by tepid ablutions, are indicated. Coldness of the extremities must be relieved by hot mustard baths and bottles of hot water.

It need hardly be added that the sooner these constitutional measures are carried into effect, the more likely will they be to prove efficient in arresting the hemorrhage; the longer the bleeding has lasted, or the greater the amount of blood lost, the more difficult will it be to arrest the disease and prevent its downward tendency. Moreover, a proper plan of treatment having been selected, it should be diligently persisted in, otherwise it will not be able to exert any beneficial influence, inasmuch as some time must necessarily elapse, in such an affection, before the system can be favorably impressed by any measures, however judicious or energetic.

Topical treatment is generally very essential. When the hemorrhage proceeds from a wound, the affected structures should, if possible, be included in a firm ligature. For this purpose, the twisted suture may be used; or, if this be impracticable, systematic compression may be made by means of a graduated compress, wet with Monsel's solution, and confined with a roller, the surface of the wound having previously been dried, so as to allow the lint to come directly in contact with the bleeding orifices of the divided vessels. Occasionally, the application of pounded ice will restrain the bleeding more effectually than anything else. Rubbing the wound freely with nitrate of silver or sulphate of copper is sometimes useful. The actual cautery, the Vienna paste, and the different acids, have all been recommended when the hemorrhage resists the more ordinary measures; but the objection to them is that, when the eschar drops off, and frequently even before, the bleeding is apt to recur with increased violence. When the blood proceeds from the nose, uterus, or rectum, the most efficient adjuvant is the tampon. Attention to the position of the part is indispensably necessary.

SECT. V.—DISEASES OF THE ARTERIES.

The arteries are liable to inflammation, acute and chronic, suppuration, softening, ulceration, and various kinds of transformations; occlusion is also met with, and is worthy of special consideration, as a cause of gangrene and other mischief.

1. ACUTE INFLAMMATION.

Acute arteritis is generally induced by external injury, or by an extension of disease from adjoining structures. Nevertheless, it occasionally exists as an idiopathic affection, or comes on without any assignable cause, chiefly in persons of a gouty or rheumatic predisposition, from the age of thirty to fifty. Restricted, in the majority of instances, to one or more of the larger trunks, it not unfrequently involves the smaller branches, and sometimes even the capillaries. Occasionally, the malady appears to pervade nearly the whole arterial system.

When arising spontaneously, the disease usually begins in the internal membrane and subserous connective tissue, from which it gradually spreads to the other tunics; the reverse being the case when it is induced by external violence. The anatomical characters of acute arteritis are redness, opacity, rugosity, and softening of the lining membrane, with an engorged, lacerable, and thickened state of the outer and middle coats. When the inflammation is severe, the parietes of the affected artery are generally remarkably pulpy, and so much diminished in consistence as to be easily torn or divided by the ligature. The nutrient vessels are loaded with blood, and often exhibit a veritable varicose aspect, their ultimate twigs ending apparently in the subserous connective tissue. With regard to the redness of the internal membrane, it is liable to considerable diversity; generally speaking, it occurs in small patches, which are diffused over a greater or less extent of surface, and which vary in diameter between that of a split pea and a five-cent piece. In intensity, it ranges from a light pink to a deep scarlet, through numerous intermediate shades of lilac and purple. In some instances the redness is uniform. With this change of color are always associated important alterations of texture. The inner

membrane, losing its smoothness and polish, assumes a rough, fleecy aspect, and, owing to the softened state of the subserous connective tissue, is easily detached from its

Fig. 307.

Fig. 308.

natural connections. Globules of lymph, either alone or blended with pus, occasionally adhere to its inner surface ; and, in the large arteries, it is not uncommon, as seen in figs. 307 and 308, to meet with well-developed pseudo-membranes, similar, in all respects, to those of the serous textures. The other tunics are also much affected, being moist, tumid, friable, and transformed into a reddish, homogeneous mass, almost devoid of cohesive power. Their elasticity, naturally so great, is partially lost, and in many instances they are freely infiltrated with serosity, sanguinolent fluid, or even pure pus. A common occurrence is the formation of fibrinous concretions, closing up the caliber of the affected vessels.

Suppuration of the arteries is probably more frequent than is commonly imagined. The matter being generally formed upon the inner surface of the vessels, is soon swept away by the circulating current, which is, doubtless, the reason why it is not oftener noticed after death. Sometimes, however, it is entangled in the substance of the false membranes, infiltrated into the arterial tissues, or collected into small abscesses between the inner and middle tunics. Arteritis is much less liable to terminate in suppuration than phlebitis, in which respect the one resembles inflammation of the serous membranes, the other of the mucous.

The arteries are almost insusceptible of *gangrene.* Their conservative powers are certainly very great, as is evinced by the fact that they often escape destruction in the midst of parts that are perfectly devitalized. In such cases, their outer surface is incrusted, at an early

Plastic Deposits of the Aorta.

Plastic Plugs occluding the Axillary Artery.

period of the disease, with a thin layer of fibrin ; and, long before the sloughs begin to separate, the blood coagulates in their interior, thus opposing an effectual barrier to the occurrence of hemorrhage.

Softening of the arteries is a common occurrence, especially in the smaller branches. It is often witnessed in organic diseases of the principal viscera, and is a frequent attendant upon acute inflammation, carcinomatous affections, and the application of the ligature. The lesion is characterized, as the name indicates, by a diminution of the cohesive power of the vessels, the coats of which are rendered friable, spongy, and inelastic. It is generally accompanied with slight tumefaction, engorgement of the capillary vessels, and effusion of serosity, or sanguinolent fluid, into the interstitial connective tissue.

The *symptoms* of acute arteritis are generally so obscure as to render it extremely difficult to distinguish it, especially when it occurs in the more deep-seated vessels. In the majority of cases, the attack strongly resembles one of rheumatism. The most reliable phenomena, in a diagnostic point of view, are excessive pain and tenderness along the course of the affected arteries, increased by pressure, cough, and change of posture, and accompanied by violent and tumultuous throbbing, which is sometimes felt over the greater portion of the body, and may often be easily perceived at a considerable distance. The action of the heart is much increased in force and frequency, the pulse is hard, wiry, and thrilling, and the system is disturbed by irritative fever, which rapidly assumes an asthenic type. When the disease is at all extensive, the patient soon succumbs under its influence, the immediate cause of death being either exhaustion from the violence of the inflammation, or from the formation of the fibrinous concretions in the larger arteries, thereby arresting the circulation in some of the more important organs.

There are no symptoms denotive of suppuration, ulceration, or softening of the arteries,

apart from those of acute or chronic inflammation. The formation of matter would probably be ushered in by rigors, followed by copious sweats, hectic irritation, and excessive prostration, but the occurrence would hardly be of so marked a nature as to serve any diagnostic purpose.

Acute arteritis is best treated by the lancet, purgatives, and antimonials, if the patient is young and plethoric, or by a conservative course, if he is weak, decrepit, or exhausted by previous suffering, intemperance, or dissipation. Aconite, veratrum, or colchicum will usually form valuable additions to the other means, especially if they be combined with morphia, which is so necessary to allay pain and quiet the heart's action. If the disease is connected with the rheumatic diathesis, calomel must be given, in full and frequently repeated doses, with a view to early but gentle ptyalism. Colchicum will then also prove useful. The most suitable topical remedies, when the affected arteries are superficial, are leeches, iodine, and saturnine lotions, in union with laudanum.

2. CHRONIC AFFECTIONS.

The most common chronic affections of the arteries are the fibrous, calcareous, and atheromatous transformations, which, although of frequent occurrence, are chiefly interesting in relation to the influence which they exert upon the production of spontaneous aneurism. It is for this reason, therefore, that they should be carefully studied. These transformations, notwithstanding that they widely differ in their physical and chemical properties, possess several characters in common, of which the most important are, first, that they are met with almost exclusively in elderly subjects; secondly, that they render the coats of the vessels brittle, and, consequently, prone to rupture; thirdly, that they nearly always occur in association; and, lastly, that they usually begin in the connective tissue, between the inner and middle tunics, which, however, in time, generally participate in the morbid action.

Fig. 309.

The *fibrous transformation* is characterized by the appearance of small, hard, firm patches beneath the serous layer of the arteries, usually isolated, but sometimes grouped, of no definite shape, thin, and of a whitish, grayish, or pale yellowish aspect. When the patches are numerous or unusually large, they convert the affected arteries into firm, inelastic tubes. The basis matter of this transformation is fibrin, which gradually undergoes the fibroid change.

The *calcareous degeneration*—the calcification of modern writers—is a disease of advanced life, although it has occasionally been noticed in early childhood, and is most common in the aorta and its larger branches, as the iliac, femoral, popliteal, and innominate. The brachial artery is seldom affected. The transformation is comparatively rare in the female; a fact which satisfactorily accounts for the difference in the relative frequency of spontaneous aneurism in the two sexes. An instance occasionally occurs in which there is a strong calcareous diathesis, nearly all the arteries in the body being converted into rigid cylinders. The abnormal matter is deposited in an amorphous form, and is destitute of bone corpuscles; consisting essentially of phosphate and carbonate of lime, in combination with a small quantity of albumen, which apparently serves as its matrix.

The calcareous matter exists in various forms; sometimes in small grains and nodules, now in scales, plates, and patches, and now in complete rings, which, encircling the vessel, convert it into a firm, rigid, inflexible tube, completely destitute of its natural attributes, as seen in fig. 309, from a specimen in my cabinet. The inevitable effect of these changes, which are always most conspicuous in the inner coat, is to render the artery abnormally brittle, and, therefore, ill able to withstand the pressure of its contents.

The starting-point of this deposit is the subserous connective tissue, whence it gradually extends to the inner and middle tunics, both of which are sometimes completely transformed by it. It is rare that the outer coat suffers from it; such a change, however, is not impossible, and I have seen specimens in which the deposit was apparently entirely restricted to it. The exciting cause of the calcareous degeneration is chronic inflammation, as is evinced by the fact that it is invariably accompanied by more or less thickening and induration of the arterial tunics, independently of those produced by the

Calcareous Deposits.

deposit itself. From investigations made a few years ago by Gubler it is highly probable that a strong predisposition to this disorder is established by the constant use of vegetables containing a large percentage of mineral substances, particularly the earthy salts.

The *atheromatous* or fatty degeneration, fig. 310, is very rare among our native inhabitants, but sufficiently common in our immigrants, especially the Irish and English. In

Fig. 310.

Atheromatous Deposits.

Europe, it is said to be more prevalent in Great Britain than in any other country; a fact which accounts for the remarkable frequency of aneurism in that part of the world. The change always begins in the subserous connective substance, generally in minute, isolated points, not larger than the head of a pin, of a pale yellowish, whitish, or brownish color, somewhat greasy to the touch, and of a semiconcrete, friable consistence. In time, many of these points, or dots, coalesce, and so form irregular-shaped patches, which, pushing the lining membrane before them, may involve the whole circumference of the tube, and extend several lines or even inches up and down in the direction of its length. Having remained stationary for an indefinite period, the deposit manifests a disposition to softening and disintegration, and is ultimately converted into a curdy, friable, or, more properly speaking, a pap-like substance, possessing, apparently, all the properties of scrofulous pus. At this stage of the disease, the lining membrane is often elevated into small pustules, or little abscesses, which, bursting, discharge their contents into the blood, thus leaving a corresponding number of ragged and irregular ulcers, cracks, or fissures, the base of which is formed by the middle tunic.
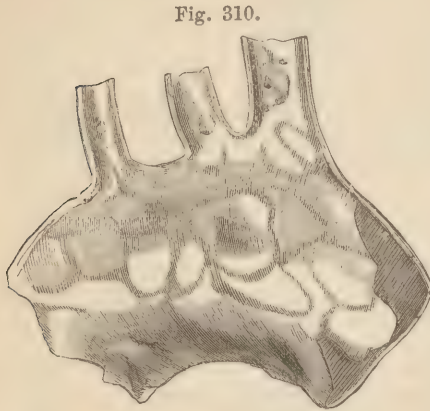
The fatty deposit is most common in the aorta, particularly in its thoracic portion, near the origin of the great cervical trunks. Its occurrence is almost peculiar to the aged. What the causes are, under the influence of which it is developed, has not been ascertained. That it is occasionally connected with imperfect alimentation, and the inordinate use of ardent spirits, is unquestionable, but that these circumstances are essential to its production is not at all probable, as the disease is frequently witnessed in the stoutest and most temperate subjects, a fact which is entirely at variance with such a conclusion.

Under the microscope the atheromatous matter is observed to consist of albuminous and earthy particles, of crystalline plates of cholesterine, of an imperfect fibrous texture,

Fig. 311.

Fatty Granules, with Crystals of Cholesterine, from Atheromatous Deposits in the Aorta.

and of oil globules. The amount of fatty substance is frequently so great that it imparts a greasy stain to paper when dried on it by heat. The minute appearances of this deposit are well shown in fig. 311.

The *amyloid*, or, more properly speaking, albuminoid, degeneration of the coats of the arteries is uncommon in the inhabitants of this country, and little is known respecting the influence which it exerts upon the production of aneurism and the repair of injuries. It always begins in the middle tunic, the cells of which are gradually transformed into compact, pellucid, hyaline particles, the effect of which is to change the affected vessel into a hard, rigid, silvery-looking cord, more or less translucent, and of a clear, glassy appearance, with a lustre not unlike that of rough ice. The deposit upon which the degeneration depends is essentially composed of albumen.

Ulceration, as a consequence of arteritis, whether acute or chronic, is seldom witnessed. Manifesting a peculiar predilection for the larger trunks, it commonly commences in the serous membrane, from which it gradually extends to the middle and outer tunics until it leads to complete perforation. Such a termination, however, is extremely rare. The ulcers, which are very irregular in their form, vary much in size, number, and general character. At times they are very small, scarcely exceeding the diameter of a mustard seed; but they may be as large as a split pea, a five-cent piece, or even a guinea, according to the caliber of the affected tube. Their margins are usually ragged, irregular, and

considerably elevated, but seldom injected ; their bottom, which is rough and uneven, is commonly formed by the middle tunic, the fibres of which frequently present a shreddy, lacerated appearance. In many instances, the erosions look like so many fissures, cracks, or chaps, with sharp, prominent, and irregular borders. This form of the disease is ordinarily dependent upon the presence of calcareous matter. The number of ulcers is seldom considerable, although in a few rare cases the inner surface of the larger trunks has been found completely checkered with them. When confined to the internal tunic, they sometimes admit of cicatrization.

In regard to the different affections now described, there are no remedies which, so far as is at present known, are capable of exerting any influence over their development and cure. What treatment might accomplish, if their diagnosis could be satisfactorily established, is an interesting problem for future inquiry to solve.

3. DISSECTING ANEURISM.

There is an affection of the arteries, occurring exclusively in old persons, more particularly in women, to which the term dissecting aneurism, fig. 312, has been applied : it is not, however, in reality, an aneurism at all, but merely a separation of the lamellæ of the middle tunic, as has been satisfactorily established by the investigations of Dr. Pennock, and by an examination by myself of nearly all the reported cases of the disease. A more appropriate name would be *intraparietal* separation. The lesion, which presents nothing of practical interest, inasmuch as it is always fatal, is entirely limited to the aorta and the larger trunks more immediately connected with it, and is always dependent upon organic disease of the coats of the arteries, rendering them lacerable, and, consequently, incapable of resisting the impulse of the blood. The manner in which the affection takes place is easily understood. In the natural state the different coats are so intimately connected together that it is almost impossible, even by the nicest dissection, to detach them from each other; but when they are altered by disease, or by some of the degenerations to which they are so liable, the connective tissue is rendered soft and friable, and their separation may then be very easily effected. In this condition, moreover, the tunics themselves are frequently very much changed, so that they are scarcely able to resist the slightest impulse. Now, if under these circumstances the lining membrane gives way, whether from ulceration, erosion, or rupture, the blood insinuates itself into the accidental opening, which is thus gradually enlarged, at the same time that the fluid is forced on between the layers of the weakened middle tunic,

Fig. 312.

The so-called Dissecting Aneurism. *a*, Semilunar Valves ; *b*, External Vessel laid open in its entire Extent, so as to Expose the Aorta at *c* ; *d*, Valvular Opening in the Coats of the Aorta, showing the Communication of this Vessel with the Artificial Channel, *b* ; the Probe *e* passed through the Abnormal Opening ; *f* exhibits the Foramina between the Aorta and the Outer Canal.

dissecting them from each other as with a knife, and forming thus either a blind pouch or a distinct canal, open at both extremities, or at some intermediate point.

The separation rarely embraces more than one-fourth, one-half, or two-thirds of the circumference of the tube, while in length it may vary from six, eight, or ten lines to as many inches. Occasionally it reaches nearly from one extremity of the aorta to the other, being, perhaps, prolonged at the same time into the carotid, subclavian, and iliac arteries.

4. VARICOSE ENLARGEMENT.

The arteries are liable to a dilated and nodulated condition, similar to that of the veins, and hence very frequently termed varicose enlargement. The affection has also been described under the name of cirsoid aneurism, or arterial varix. Its general features are well illustrated in fig. 313. The lesion, which is exceedingly rare, is met with chiefly in

the superficial arteries, particularly in those about the hand, forearm, leg, and foot ; and consists in a remarkably tortuous, elongated, and convoluted state of these vessels, evidently dependent upon the effects of inflammatory action, as is shown by the fact that their coats are always abnormally thickened, either uniformly, or alternately thickened

Fig. 313.

Varicose Enlargement of the Arteries of the Hand.

and attenuated.   In elderly subjects it is generally associated with the fibro-cartilaginous, earthy, or fatty degeneration.   The dilatation and varicosity sometimes affect an entire artery, but more commonly they are limited to particular portions of it ; they may be restricted to one vessel, or occur simultaneously in several.   When the diseased artery is superficial, the character of the lesion is rendered sufficiently clear by the tortuous and nodulated course of the vessel beneath the surface ; but there are no pathognomonic signs when it is deep-seated.

This affection rarely requires any treatment ; for, even when the enlargement is considerable, it is rather an inconvenience than an actual disease.   In ordinary cases, the vessels may be supported by the constant use of a well-applied bandage, or of an apparatus constructed upon the principle of the laced stocking.   During the forming stage, much may be done in the way of repressing development by astringent and soothing lotions, along with rest and elevation of the parts, and the occasional abstraction of blood, provided the patient is plethoric, in order to moderate the momentum of the circulation. When the disease proves troublesome, by causing pain and functional disorder, the only effectual remedy is ligation of the offending vessels, at the cardiac side of the enlargement.

5. OCCLUSION.

Accidental occlusion of the arteries was long ago noticed by pathologists, but its great practical importance was not fully appreciated until within a comparatively recent period. One form of gangrene, the senile, so graphically described by Pott, has long been known as one of its principal effects.

The causes of accidental occlusion are various.   The most important are, 1st, acute inflammation ; 2dly, the atheromatous and calcareous degeneration of the coats of the vessels ; 3dly, embolism, or the formation of clots ; 4thly, fibrinous concretions; 5thly, morbid vegetations ; 6thly, pressure of the ends of fractured bones ; 7thly, exuberant callus ; and, lastly, different kinds of tumors, soft, hard, and aneurismal.

The effects of acute arteritis and the atheromatous and calcareous degenerations of the coats of the arteries upon the circulation have already been considered under the respective heads of those maladies.   Such changes, which are most common in the aorta and its larger branches, and in the arteries of the inferior extremities, are very liable to be followed by the formation of clots and fibrinous concretions, by which the caliber of the vessels is obstructed and the nutrition of the parts supplied by them materially impaired, if not completely interrupted.   Embolism, properly so called, acts precisely in a similar manner.   Clots are liable to form in all arteries, large as well as small, often suddenly and unexpectedly, and followed by the worst results, both local and general. Inflammation of the lining membrane of the arteries, attended with a deposit of plasma, is generally the exciting cause of embolism, the blood as it sweeps over the affected surface becoming adherent to it, and thus acting as a nucleus around which the fluids concrete.   Embolism has been noticed in all the principal organs of the body, as well as in all the main arteries of the extremities, especially the lower.   Fibrinous concretions

are sometimes detached from the interior of an aneurism, and, being transmitted into the distal portion of the diseased artery, effectually arrest its circulation. The valves of the heart in gouty and rheumatic affections are liable to be studded with morbid vegetations, which, being accidentally detached, occasion obstruction in the arteries, often followed by gangrene and other grave effects. These vegetations may, like the clots in embolism, be transported by the sanguineous current to remote parts of the body, and thus cause occlusion and disease in vessels up to that period in a perfectly sound condition.

An artery compressed by the projecting end of a broken bone is sometimes occluded in its distal extremity as completely as if it had been embraced by a ligature. Similar effects may be produced by the pressure of exuberant callus, of an exostosis, and of fibrous and other morbid growths. Under such circumstances, however, the obstruction usually occurs slowly, not rapidly or suddenly, as when it is caused by the projecting extremity of a fractured bone. The pressure of an aneurism may lead to occlusion of the distal arteries, as is occasionally witnessed in popliteal aneurism, the effect of which is to block up the arteries of the leg and to bring about gangrene in the unnourished structures.

Embolism, however induced, is not peculiar to any period of life, although it is unquestionably most common in the aged. This, however, is true mainly of the chronic form of the affection; for the acute, if so it may be termed, or that which arises suddenly, is not unfrequently met with in very young subjects, and even in children and infants, although such an occurrence is very infrequent.

The most common effect of accidental occlusion of the arteries is gangrene in the structures below the seat of the obstruction. Such an occurrence is almost a necessary and inevitable consequence of sudden obstruction; in chronic cases, on the contrary, the circulation may be maintained by the collateral vessels, and the clots be even ultimately absorbed, although such a termination is very uncommon. Instantaneous death may be produced when a clot suddenly finds its way into the heart, the mouth of the aorta, the lung, or the brain. Organs supplied by a single artery, as the retina and testicle, lose their function and fall into a state of atrophy when their circulation is thus cut off.

The *symptoms* denotive of arterial occlusion are generally so obscure as to render the diagnosis exceedingly difficult, if not impossible, in the earlier stages of the occurrence. Obstruction of the trunks of the extremities is usually attended by a sense of numbness and tingling along the course of the principal vessels, rapidly followed by tenderness and pain, both of which are often extremely violent. The skin, at first pale, soon becomes purple, and then mottled; temperature, motion, and sensation are diminished, and the impoverished structures are finally seized with gangrene. Sometimes the pain is of a wandering character, very much as in gout or rheumatism; and cases occur, although rarely, in which it is perceived at distant parts of the body. More or less fever generally attends, and the system, in most cases, speedily sinks into a typhoid condition. Children and young subjects commonly bear up better under arterial occlusion than elderly persons, few of whom recover. Acute occlusion is more dangerous to life than chronic, and is generally more rapidly fatal.

The *treatment* of arterial occlusion is unsatisfactory. In general, little can be done beyond attention to the posture of the limb, and the preservation of its temperature by means of cotton and flannel, the relief of pain by anodynes, and the maintenance of the strength by suitable food and drink. Moist applications are usually hurtful. When gangrene arises, the object should be to promote the separation of the sloughs, and to prevent fetor by the liberal use of deodorizers, fresh air, and rigid attention to cleanliness. Amputation is seldom proper, especially in chronic cases, even when a distinct line of demarcation exists, experience having shown that, unless the patient possesses uncommon constitutional vigor, the operation generally proves fatal. Now and then there is, of course, an exception, but death is unquestionably the rule. In the acute form of the affection amputation sometimes succeeds in saving life, provided there is a well-formed line between the dead and living structures, with a good state of the system, and perfect exemption from internal complications.

SECT. VI.—ANEURISM.

An aneurism may be defined to be a pulsating tumor, occupied by blood, and communicating with an artery deprived, either partly or completely, of its integrity.

The subject of aneurism has been encumbered by too many divisions and subdivisions, and the consequence is that several lesions have been included under it which do not, properly speaking, appertain to it. The effect of this overrefinement has been to embarrass the study of this disease, and to invest it with difficulties which are altogether foreign to it. The distinction of aneurism into true and false is one of great importance, and should, therefore, be retained. The same may be said in regard to spontaneous and traumatic aneurism. The term dissecting aneurism, introduced by Laennec, and adopted by most modern authors, should be discarded, inasmuch as the affection which it serves to designate has nothing whatever in common with aneurism; it is, in fact, as already stated, merely a separation of the coats of the arteries, without any tumor or symptoms denotive of that lesion. Then again, as to the term varicose, which I have myself, along with others, employed, in my writings, to designate a peculiar form of arterial lesion, it is obviously improper when we come to make a practical application of it. A varicose artery is, in reality, no more an aneurism than a varicose vein; both affections consist essentially in a dilated and tortuous state of these two classes of vessels, and not, as an aneurism, in a pulsating tumor, caused by the destruction, partial or complete, of the tunics of an artery. An anastomotic aneurism is a pulsating tumor formed by hypertrophy of the arterial and venous capillaries of a part; critically speaking, therefore, the term aneurism is not applicable to it, and yet, as it has been fully engrafted upon our surgical nomenclature, it is difficult to dispense with it, or to substitute one of a more expressive and appropriate character.

The term true is applied to that species of aneurism in which one or more of the arterial tunics, without being necessarily perfect, form a part of the tumor. In a false aneurism, on the contrary, all the coats have given way, and the sac is composed of condensed connective tissue. It was formerly supposed, chiefly through the influence of the writings of Scarpa, that there was no such disease as a true aneurism, but that in every instance, whatever might be the size, form, or site of the tumor, there was a complete absence of the arterial tunics. This opinion, however, has become obsolete, experience having shown that there are cases, although they are confessedly rare, in which the aneurism clearly consists of at least one, if not more, of the coats of the artery from which it springs. Each of these great divisions comprises several varieties, founded principally upon the form and volume of the tumor. Thus, an aneurism is said to be sacculated when it consists of a distinct pouch, as so often happens in aneurism of the aorta and its principal branches; the term cylindroid is used when the swelling affects the artery uniformly in its entire circumference, while the tapering tumor is known by the appellation of fusiform. The words circumscribed and diffused refer mainly to the dimensions of the aneurism.

Fig. 314.

Fig. 315.

Fig. 316.

Fig. 317.

The annexed sketches afford a good idea of the arrangement of the tunics of the arteries in the principal varieties of spontaneous aneurism. In fig. 314 the tumor is formed by the expansion of all the coats of the vessel, an extremely rare event; in fig. 315 the middle tunic has given way, the inner and outer being preserved; in fig. 316 the aneurism is formed by the external tunic alone; in fig. 317 the two outer membranes have been ruptured, the inner projecting through the crevice thus left in the form of a hernia. This variety is very uncommon, but cases of it have been reported by different authors, especially by Haller, Laennec, Dupuytren, and Dubois. It can occur only when the inner coat of the artery has been thickened and fortified by interstitial and surfacial deposits.

Finally, aneurisms are divided into internal and external, the former expression being used chiefly in reference to the aorta and to the arteries of the viscera, the latter in relation to the vessels of the head, neck, and extremities. The words spontaneous and traumatic sufficiently explain themselves.

1. LOCALITY, PREVALENCE, AGE, SEX, AND CAUSES.

Spontaneous aneurism does not occur with equal frequency in all parts of the body; on the contrary, there are a number of arteries which are almost entirely exempt from it, or
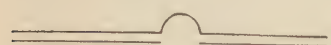
which, at all events, so seldom suffer as to be scarcely entitled to notice. The vessel which is most frequently involved is the aorta; first in its ascending portion, then in the thoracic, and lastly in the abdominal. Next in point of liability to the disease are the popliteal artery, the femoral, common carotid, subclavian, innominate, axillary, and external iliac. The arteries of the leg and foot, hand, forearm and arm, face, upper part of the neck, and of the viscera, together with the common and internal iliac, rarely suffer in this wise. Traumatic aneurism may occur in any of the arteries, but is most common in those that are most exposed to external injury.

Of the causes which induce spontaneous aneurism more frequently in one artery than in another, nothing definite is ascertained. Several circumstances, however, may be assigned as affording at least a plausible explanation of the circumstance.

1. It is well known that certain arteries are peculiarly prone to the calcareous and atheromatous degenerations, while others are almost entirely exempt from them, whatever may be the condition of the rest of the arterial system, or the age of the patient. Now, dissection has shown that those vessels which are most frequently diseased in this way are also those which are most frequently affected with aneurism, and conversely. Spontaneous aneurism of the arm and forearm is among the rarest occurrences, and everybody knows how free their vessels are from the degenerations in question. In the aorta and popliteal artery, on the other hand, they are extremely common, and it is here, as already seen, that spontaneous aneurism is most frequent.

2. In the next place, some influence is no doubt due, in the production of this difference, to the force with which the blood impinges against the walls of the vessels. Thus, in the aorta, which is more prone to aneurism than any other artery, the ascending portion, particularly its anterior and right side, suffers more frequently than any other part, and it is here that the blood exerts its greatest force, as it is pumped up from the left ventricle. The popliteal artery, which comes next in the order of involvement, is subjected, in a degree beyond that of any other vessel in the extremities, to a similiar influence during the flexed condition of the limb.

3. It is not improbable that some influence is also due to the weakness which the arteries experience at the origin of their larger branches. The fibres of the middle tunic suffer a species of separation here, in consequence of which they are less capable of withstanding the shock of the blood as it is directed against them. However this may be, experience teaches that aneurism is peculiarly liable to occur at these points.

4. Another circumstance which may be supposed to favor the production of aneurism is the motion to which the arteries are subjected, especially during sudden and violent efforts. Such an influence must be particularly felt by the ascending portion of the aorta during bodily and mental excitement, and by the popliteal artery in the various muscular exertions of the lower extremity.

How far any one of these causes alone is capable of producing aneurism is altogether a matter of conjecture. Without degeneration of the arterial tunics, they would probably exert but little influence, while under opposite circumstances it must be very great. Indeed, it is very questionable whether aneurism would be the one-twentieth part as common as it is, if the arteries were exempt from the earthy and atheromatous deposits; nay, we may go further, and assert, positively, that if these deposits could be prevented, spontaneous aneurism would almost cease to exist.

The occurrence of aneurism would seem to be influenced by climate or *locality*. The infrequency of the lesion in the inhabitants of the southwestern States of North America is proverbial. In an extensive practice in Ohio and Kentucky of twenty-three years, I rarely met with an example of spontaneous aneurism; and my experience, in this respect, is fully borne out by that of the late Dr. Dudley, of Lexington, whose practice embraced a wide field, afterwards so successfully cultivated by Professor James B. Bush. The testimony of other western and southwestern surgeons is precisely of the same import. To what this extraordinary immunity is due, we have no means of determining. The population of those regions of the United States is a mixed and laborious one, made up from all parts of the civilized world, and pursuing all kinds of occupations, from the most delicate and refined to the most rude and vigorous, and yet a case of spontaneous aneurism, in any class of its citizens, is absolutely an anomaly. The disease, if I mistake not, is equally uncommon in our northern and middle States.

In regard to the prevalence of aneurism in our larger towns and cities, our information is very imperfect. Professor Gibson, formerly of the University of Pennsylvania, asserts that the disease is very uncommon in Philadelphia, and this I know to be the fact from the results of my own observations. In New York, on the contrary, it would seem,

according to the statement of Dr. Mott, to be quite frequent; a circumstance which is, perhaps, not surprising, when we consider the heterogeneous character of the people of that city, and, above all, the extent of its commerce, and the numerous accidents incident to its pursuits. What is remarkable, however, is, that all the cases met with by this distinguished surgeon, during a period of nearly forty years, occurred among native-born citizens of the United States. In opposition to this fact, however, I have the authority of Dr. John Watson and others, of New York—as communicated to me by Dr. Lente—for stating that the great majority of cases of aneurism in that city, especially in hospital practice, are met with among those of foreign birth. Its negroes would also seem to be particularly liable to the disease.

Aneurism is uncommon in the East and West Indies, in the British Provinces of North America, and on the continent of Europe, especially in France, Italy, and Germany. In Great Britian, on the contrary, it is sufficiently frequent; more so, perhaps, than in any other part of the globe. According to the report of the registrar-general, it appears that the number of deaths from aneurism, in England and Wales alone, during a period of five years—namely, from 1838 to 1842—was 593; being an annual average of one in about 131,000 of the inhabitants. The various hospitals of London receive every year a large number of cases of this disease. The people of Ireland are said to suffer more frequently from aneurism than any other race. In Egypt aneurism is almost unknown.

The *causes* of aneurism are predisposing and exciting. Of the former, the most constant, and, therefore, the most important, is a diseased condition of the arterial tissues, usually in the form of the earthy or atheromatous degeneration. These degenerations, by rendering the coats of these vessels preternaturally brittle and lacerable, induce them to yield more readily under the impulse of the blood and the various extraneous circumstances which have a tendency to stretch and twist them. I have already expressed the belief that, but for these alterations, spontaneous aneurism would be almost unknown. All laborious pursuits, involving sudden and violent muscular exertion, powerfully predispose to its occurrence. Hence, it is more common among sailors, and those who are much accustomed to athletic exercises, than among any other classes of individuals. Soldiers suffer much less frequently than was formerly supposed. Men engaged in agricultural pursuits, although their labor is often severe, are, in great measure, free from the disease, owing to the fact that their arteries are singularly exempt from the calcareous and atheromatous degenerations. Popliteal and femoral aneurism used to be sufficiently common in Great Britain among post-boys, but their frequency, according to Dr. P. H. Watson, has much diminished since the introduction of railroads has replaced this class of persons. Protracted courses of mercury, a syphilitic taint of the system, and the constant and inordinate use of ardent spirits, are supposed to predispose to the formation of aneurism; but how far, or in what degree, remains to be demonstrated.

Embolism is an occasional cause of aneurism, especially of the popliteal artery, producing first obstruction of the caliber of the vessel, and then softening and expansion of its coats. Traumatic aneurism, as the name implies, is the result of external injury, as various kinds of wounds, incised, lacerated, punctured, and gunshot. Roux has reported a case in which an aneurism of the axillary artery was produced by the pressure of an exostosis; and Dr. Thomas, of Closmadeuc, met with a similar occurrence in the popliteal artery. Dr. Castle, of New York, saw a case in which the disease was developed in the palatine artery by the pressure of the plate of a set of artificial teeth.

The formation of aneurism is remarkably influenced by age. Prior to the thirtieth year the disease is extremely rare, and up to the period of puberty it is almost unknown, even in the aorta, which is so much more frequently affected than the other vessels. The greatest number of cases, by far, occur between the thirty-fifth and fiftieth years; a good many cases are also met with during the next decennial period and a half, but after that time the malady is very rare; probably not that the predisposition to it ceases, but because, as it seems to me, in the first place, the number of subjects is comparatively small; and, secondly, because persons at this age are much less exposed to violent muscular and mental excitement than during the meridian of life. That this supposition is true is rendered highly probable by the fact that the earthy and atheromatous deposits generally exist in greatest abundance in advanced life. The absence of these deposits in young subjects readily explains the rarity of aneurism in children and adolescents.

Although spontaneous aneurism in early life is very uncommon, examples have been noticed by different observers, all, apparently, referable to the effects of embolism. Mr. Syme, in 1844, operated upon a boy for a popliteal aneurism that had made its appearance at the age of seven years; and he alludes to two other instances in which the disease occurred

in children.   Sir Astley Cooper met with it in the anterior tibial artery at the age of eleven years; Mr. Hutchinson, in the arch of the aorta at four; Mr. Armitage, in the abdominal aorta at seven and a half; and Dr. Ogle, in the ulnar artery at seventeen. Dr. W. S. Church, of London, has published a table of thirteen cases of intracranial aneurism occurring in subjects under twenty years of age.

The immediate cause of aneurism is rupture of the coats of the arteries, in consequence of severe muscular exertion unduly stretching these vessels; or, as in the case of the aorta and its larger offsets, an inordinate impulse of the blood, during the sudden and violent contraction of the left ventricle of the heart.   The vessels, weakened by chronic inflammation and the degeneration of their tissues, and deprived of their elasticity, readily yield to the forces thus applied, commonly at a particular point, which is afterwards converted into a distinct pulsating tumor, generally composed, in great measure, if not exclusively, of the external tunic of the artery, along with more or less of the circumjacent connective tissue.   Sometimes the exciting cause of the disease is ulceration, but such an occurrence is comparatively rare, especially as an affection independent of the earthy and atheromatous deposits.   The process, as stated in a previous section, should not be confounded with the cracks or fissures which so often follow upon these deposits, inasmuch as the latter are usually the result, not of a vital action, as in true ulceration, but of a mere mechanical one, gradually effected under the impulse of the blood, as it rushes over the inner coat of the diseased vessel.

Aneurism occasionally exists simultaneously in several arteries.   Thus, it is by no means uncommon for a patient to have one tumor of this kind in the aorta, and another in the carotid, subclavian, popliteal, femoral, or external iliac artery.   I have seen several instances of the coexistence of popliteal aneurism on both sides in the same individual. When the disease affects a considerable number of arteries, it constitutes what is termed the *aneurismal diathesis;* a circumstance which, as a rule, imperatively contraindicates surgical interference, however favorably the external tumor may be situated for operation. Weak, sickly persons, of depraved constitution, and intemperate habits, are the most common subjects of this diathesis.   Several remarkable examples of this predisposition to the formation of aneurism are upon record.   Pelletan gives one in which the number of tumors was upwards of sixty, and in another, related by J. Cloquet, there were more than two hundred, the patient being a man fifty years of age.   The aneurisms, in this instance, affected nearly all the arteries in the body, but they were most numerous in those of the extremities, the axillary, brachial, radial, ulnar, femoral, popliteal, tibial, and peroneal being all closely studded with them.

Sometimes two aneurisms form in close proximity with each other; and, the fact not being recognized beforehand, may, in the event of an operation, cause so much embarrassment in the attempt to pass the ligature as to necessitate its abandonment.

Men suffer from aneurism more frequently than women, but in what precise proportion is not determined.   The question has hitherto engaged but little attention, and it is obvious that it can only be decided by the analysis of a much larger number of cases than have yet been adduced for the purpose.   It has been alleged that the relative frequency of carotid aneurism in the two sexes is nearly equal, and the occurrence has been attempted to be accounted for on the supposition that the arteries of the neck of the female are nearly as much exposed to all kinds of violence and muscular exertion as those of the male. Little confidence, however, can be placed in such opinions; for, before we can receive them as true, we must be satisfied that the disease is as common in women as in men, which I am very certain it is not.   The statistics of Mr. Crisp show that of 551 cases of aneurism of all kinds, more than seven-eighths occurred in men.

Having long been impressed with the belief, founded upon numerous dissections, that the difference in the relative frequency of aneurism in the two sexes was due, not to any difference in their occupation, but to the difference in the relative frequency of the earthy and fatty degenerations of the arteries, I was induced to institute a special inquiry into the subject, and am gratified to be able to say that my views are fully confirmed by the statements of Professor Agnew, Dr. C. E. Isaacs, T. G. Richardson, and J. B. S. Jackson.   The testimony of these teachers, all well known as able and experienced practical anatomists, tends to show, indisputably, that females are much less subject to chronic disease of the arteries of every description than males.   Neither their information, however, nor my own, is such as to enable me to determine the relative proportion of these degenerations in the two sexes, in a given number of cases; but that it corresponds very closely with the difference in the number of cases of aneurism is, I think, fully established.

If what is here said be true, it follows that the opinion which ascribes the greater fre-

quency of spontaneous aneurism in males than in females to their more laborious occupation, their more intemperate habits, and their greater exposure to all kinds of disease, is entirely untenable, and, therefore, unworthy of confidence. Women, it is true, are not sailors, carpenters, blacksmiths, or hod-carriers, but in many parts of the world they are tillers of the soil, and engaged in almost every variety of pursuit calculated to rupture the arterial tunics if they were in a serious state of disease, such as we so often meet with in the other sex.

2. VARIETIES OF ANEURISM.

True aneurism presents itself under two varieties of form, differing from each other materially in their appearance and mode of formation, although their essential symptoms and effects are usually perfectly similar, if not identical. These two varieties are the tubular and the sacciform, terms which are sufficiently expressive of their general confor-

Fig. 318.

Sacculated Aneurism.

mation. Each consists of one or more of the arterial tunics, and forms a tumor, which, in time, is capable of exerting the most injurious effects upon the neighboring structures, and of causing the death of the patient. The diffused aneurism, properly so called, is always the result of a diseased condition of the circumscribed, especially of the sacculated.
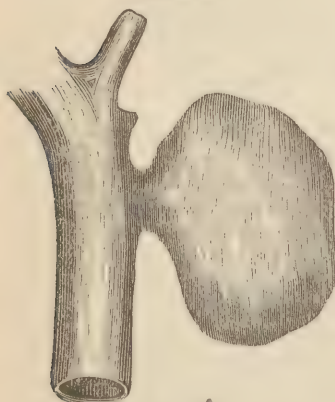
The *sacciform variety*, fig. 318, is by far the more common of the two. It essentially consists, as the name denotes, in the formation of a pouch, bag, or sac, connected with the side of the affected artery. In the tubular variety the tumor is formed at the expense of the entire circumference of the vessel; in this, on the contrary, it occupies only a limited portion of it. The arteries most liable to sacciform aneurism are the aorta, particularly its thoracic division, the popliteal, femoral, innominate, carotid, and subclavian. The number of tumors is subject to considerable diversity; cases have been reported in which there were so many as to constitute a genuine aneurismal diathesis, nearly all the principal arteries in the body being more or less implicated. In general, however, there is only one, although others may be developed during its progress. Thus, it occasionally happens in popliteal aneurism that an aneurism forms in the aorta, the carotid, or in the popliteal artery of the opposite side.

The sacciform aneurism is capable of assuming a great variety of forms; the most common is the globular or ovoidal; in rare cases it is conical, elongated, or irregularly flattened, like a shot-pouch. Much diversity also obtains in regard to its dimensions; thus, while in some instances it is hardly of the volume of a hazelnut, in others it is as large as a fist, or the head of the patient; in general, however, it does not exceed a hen's egg, or a medium-sized orange. The largest aneurisms of this kind are usually found in the aorta, and in the popliteal, iliac, and innominate arteries. The attachment of the

Fig. 319.
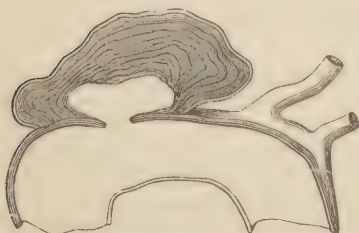
Aneurism of the Aorta: the greater part of the Sac being filled with clots, and the Aperture of Communication being small.

tumor to the artery is commonly effected by a narrow footstalk; but cases occur in which it takes place by a broad and extended base, and it is then not unusual for the artery to suffer serious compression during the progress of the disease.

The orifice of communication, fig. 319, between the sac and the artery varies in different preparations. When the tumor arises by a narrow footstalk, the opening is usually proportionately small, with smooth and well-defined margins. When, on the other hand, it is attached by a broad base, the aperture is always much larger, and its edges are also more irregular, sometimes, indeed, quite shreddy and ragged, as if they had been torn. The situation of the orifice is commonly towards the centre of the sac but it may be at one side, or even at one of its extremities. The form of the opening is extremely variable, and admits of no specific description. In the early stage

of the disease, and in nearly all cases where the tumor is small, the orifice is of a rounded or circular configuration, while in cases of an opposite character it is generally more or less irregular. The internal and middle tunics may terminate abruptly at the margins of the opening of communication, or they may extend into the cavity of the sac, and thus serve to give it a partial lining.

The sac generally consists simply of the external tunic, the inner and middle having given way either prior to, or during, the development of the disease. The first thing, in fact, that commonly happens, in all such cases, is the destruction, by ulceration or some other disorder, first, of the internal, and, soon after, of the middle layer of the artery, leaving thus a kind of crevice, which gradually enlarges under the influence of the impelling column of blood, and thus permits the corresponding portion of the vessel, now, of course, greatly weakened, to be converted into a pouch. This pouch, usually called the aneurismal sac, is then originally composed exclusively of the external coat of the affected vessel, the other strata terminating abruptly at the margin of the opening of communication, neither of them being prolonged into its interior. But this pouch would be very weak, and, consequently, ill adapted to withstand the shock of the blood as it rushes into its interior, if it were not strengthened by adventitious aid, derived from interstitial deposits in the surrounding connective tissue. We accordingly find that nature, ever on the alert to save the part and system, is prompt in supplying the required relief by setting up inflammation and pouring out plastic matter, both in the substance of the sac and in the neighboring structures, thereby thoroughly gluing them together, at the same time that they are greatly increased in thickness and density, and thus enabled more effectually to resist the effects of the ever-beating, dashing, and tumultuous sanguineous current within. Such aid, then, is wise and needful, and, fortunately, always comes in play at an early stage of the disease, the laceration of the inner and middle tunics of the artery, and the pressure of the blood against the tumor, being sufficient causes of inflammation. When the periosteum contributes to the formation of the sac, as it occasionally does in aneurism of the thoracic aorta, the walls of the tumor may be partly earthy, or even partly osseous.

Although the sac is generally composed of the outer tunic alone, cases, nevertheless, occasionally occur where it consists, in the first instance, exclusively of the inner coat, the other two having given way. That such an arrangement is exceedingly infrequent, is proved by the fact that many surgeons of large experience have warmly contested the possibility of its existence. Haller and his contemporaries, however, met with undoubted cases of it, and, in more recent times, it has been witnessed by Breschet, Dupuytren, and other observers, who have given particular descriptions of it. One ground for assuming that this form of aneurism cannot occur, is that it has never followed the numerous attempts that have been made to produce it in the inferior animals, by exposing the carotid artery and dissecting off its outer and middle tunics. In every experiment of this kind, the denuded membrane maintained its integrity, and the breach was speedily repaired by a free deposit of plastic matter. There is, however, no analogy between a sound and a diseased artery, and this fact should be borne in mind in the discussion of the subject. When the outer and middle tunics are destroyed by ulceration, as they always must be in such a case, not rapidly, but slowly, it is not difficult to suppose that the inner membrane may, at the injured and weakened part of the vessel, be made to bulge across the opening, in the form of a thin, translucent cyst. Interstitial deposits would soon aid in strengthening the cyst, although ere long, and before it has acquired any considerable bulk, it would be obliged to yield to the resistless impulse of the blood within. Haller has described this variety of aneurism under the term hernia of the inner coat of the arteries.

Cases in which the sac consists of the outer and inner coats of the artery, the middle having been destroyed, although also exceedingly infrequent, are more common than those in which it consists of the internal tunic alone. Such an arrangement is occasionally observed in aneurism of the carotid, femoral, and popliteal arteries; but, in time, the lining membrane is sure to give way, leaving thus the cyst composed of the outer coat and of the surrounding tissues, as in the ordinary form of sacculated aneurism.

The sac varies in thickness in different cases and under different circumstances, from the fourth of a line to the fourth of an inch. It is often remarkably tough, and, in cases of long standing, it is generally composed of several distinct strata, of a grayish, whitish, or drab-colored aspect, consisting of fibres which intersect each other in every conceivable direction. The outer surface of the tumor is rough and shreddy; the internal,

on the contrary, is smooth and polished, only, however, as a general rule, in its earlier stages, for in time it also becomes rough, and is finally incrusted with fibrinous matter.

Fig. 320.

Sacciform Aneurism of the Aorta ready to give way.

Notwithstanding the thickness of the aneurismal sac, and the efforts which nature makes to strengthen it, it gradually dilates, as in fig. 320, under the impulse of the inflowing column of blood, and at length, after the lapse, perhaps, of several months, manifests a disposition to yield at one or more points, very much as an abscess, the activity of the absorbent vessels exceeding that of the capillary.

The sacciform aneurism always contains, even at an early period of its formation, *fibrinous concretions*, the presence of which constitutes one of its most interesting and important features, as they are evidently designed not only to strengthen the tumor, but to aid in its obliteration, and, consequently, in the production of a permanent cure, although such an event is extremely rare. In their arrangement, these clots are always concentric, not unlike the layers of an onion, one being piled upon, and closely connected to, another. Their color and density vary according to the period of their formation, the older being usually of a pale, yellowish appearance, and of a firm, fibrous consistence, while those that are of a comparatively recent date exhibit very much the aspect and consistence of a common heart clot. Their thickness ranges from the fourth of a line to that of a sheet of paper, their number being often immense, thousands existing in a tumor, perhaps, not larger than an ordinary fist. That these concretions are organized, at least in many cases, is evinced by their intimate adhesion, not only to each other, but also to the inner surface of the sac, by their extraordinary density, and by their yellowish hue, which contrasts most strikingly with that of recently deposited fibrin and coagulated blood. These circumstances show that these lamellæ undergo most important changes after they have been deposited; that absorbent vessels are busily engaged in carrying away the serum and coloring matter of the blood, and in solidifying the fibrin after it has been extricated from the general mass; while the successive development of concretions clearly denotes that the process is as much a vital as a mechanical one. No arteries and veins have, I believe, yet been demonstrated in them; but that such vessels are always present—often, indeed, in great numbers—in cases of long standing, does not admit of any reasonable doubt. We may, therefore, look upon these clots as exceedingly interesting structures, capable, after a certain period, of maintaining a kind of independent existence. Their primary object evidently is to strengthen the aneurismal sac, and, under favorable circumstances, to fill it up, so as to effect a radical cure. What adds to the force of this conclusion is the fact that, when a cure of this description has been effected, the tumor is gradually brought under the influence of the absorbent vessels, by which it ultimately entirely disappears, with the exception, perhaps, of a little nodule not larger than a pea, and just sufficient to indicate the former site of the disease. It is proper to state that the recently-formed strata of an aneurismal sac are, in general, very imperfectly, if at all, organized; they are certainly not vascularized and furnished with absorbents.

How are these aneurismal concretions formed? Upon this subject there still exists some contrariety of sentiment. Most pathologists, however, suppose, and very correctly, as I think, that they are deposited from the blood as it sweeps over the inner surface of the sac, during which more or less of its fibrin is disengaged, while the other elements of the fluid are sent forward to mingle with the current in the affected artery. This opinion derives plausibility from the fact that the development of these strata always proceeds most rapidly when there is a comparatively small orifice of communication, with a languid state of the systemic and of the aneurismal circulation. It has been conjectured that the clots had their origin in an effusion of plastic matter, such as occurs in injuries and ordinary inflammation; but for such a view I can myself perceive no just ground, as it is impossible to discover the slightest similarity between the two processes. The act of formation, as stated in the preceding paragraph, is both a mechanical and a vital one; mechanical, as far as the mere separation of the fibrin from the blood is concerned; vital, as it respects the decolorization, condensation, and intimate adhesion of the concretions.

The *tubular aneurism* is extremely rare; it is observed principally in the aorta and

its larger branches, especially the innominate, carotid, and iliac, and consists in a uniform dilatation of the vessel, usually composed of all its tunics in varying degrees of alteration. In its shape, the tumor is commonly somewhat spindle-like, and hence it is often described under the name of fusiform aneurism ; the term cylindroid has also been applied to it, as its conformation occasionally partakes strongly of that character. The word tubular, however, is more expressive of its appearance, and I therefore adopt it in preference to any other. The annexed drawing, fig 321, from a specimen in my collection, affords a good idea of this variety of the disease.

The size of the tubular aneurism varies from slight increase of the normal diameter of the vessel to a tumor capable of receiving a large fist. When it occupies the arch of the aorta, it often projects up into the neck so as to form a prominent swelling above the sternum, admitting of satisfactory examination, both by touch and auscultation. The distance between the roots of the carotid arteries is greatly increased, and the aneurism generally encroaches sensibly upon the heart. In nearly every instance its length considerably exceeds its diameter. The dilatation of which it consists seldom terminates abruptly, but is lost by insensible degrees in the vessel above and below, thus giving the tumor the appearance of two cones united at their

Fig. 321.

Tubular Aneurism of the Aorta.

bases. In the smaller arteries, as, for example, the innominate, the aneurism sometimes involves the whole length of the vessel.

The structure of the tubular aneurism is usually made up of all the tunics of the affected artery, in a notable state of alteration, of which hypertrophy constitutes the most striking feature. In two remarkable specimens in my collection, the different tunics are immensely thickened, and increased in strength and density, the effect, evidently, of long-continued interstitial deposits ; they both occupied the arch of the aorta, extending as far as the root of that vessel, and were taken from male subjects upwards of fifty years of age. The lining membrane has lost its white and glossy appearance, and has been replaced by a thick, opaque, and rugose structure, having none of the properties of the original texture. The middle coat is at least ten times as thick as natural, very strong, elastic, and deprived of its yellowish hue ; the outer one is also greatly changed in its appearance, being remarkably strong, thick, and firm. No evidence whatever exists in any of the tunics of the earthy, atheromatous or fatty degeneration.

From a careful examination of this form of aneurism, it appears to me to consist essentially in a dilatation of the caliber of the artery, with hypertrophy of its different tunics. The first step, probably, in its formation is chronic inflammation, causing weakness of the walls of the vessel, and uniform enlargement of its diameter. By and by, however, as the dilatation increases, the coats become strengthened in every direction by interstitial deposits, and it is thus that a tumor is at length formed, capable of offering great resistance to the impulse of the blood. It is owing to this superaddition of matter that the tubular aneurism so seldom gives way by rupture ; a circumstance in which, as well as in several others, it differs remarkably from the sacciform variety of the disease.

It is not to be supposed, from what precedes, that this form of aneurism always consists of the different tunics of the affected artery ; this is unquestionably true in most cases, but we now and then meet with an instance in which the lining membrane, and perhaps, also, the middle layer, are partially deficient, thus causing irregularity in the dilatation, unless, as occasionally happens, the defect is atoned for by plastic deposits. Indeed, the retention of all the tunics would seem to be an essential condition to the formation of the true tubular aneurism ; if the inner and middle lamellæ be destroyed, even to a small extent, the blood will dilate the vessel unequally, and inevitably give rise

to a sacculated tumor. It is in this way that may be explained the occasional coexistence of the two forms of the malady.

The tubular aneurism is remarkable, besides some of the characters already pointed out, for the absence of fibrinous concretions, which are so common in the sacciform; and the circumstance may be employed as an additional evidence of the correctness of the view, so long and so generally entertained, that the formation of these substances takes place directly from the circulating fluid, and not, as some have conjectured, as an effect of the deposition of plastic matter, consequent upon inflammation. If the development arose in the latter way, it ought to be of frequent, if not of constant occurrence, inasmuch as the inner coat of the affected artery is seldom entirely free from inflammation, and would thus afford a large surface for the effusion of fibrin; but every one who has ever examined a specimen of tubular aneurism knows how extremely rare it is to find its walls incrusted with anything. In the annexed sketch, fig. 322, from Hodgson, a tubular aneurism is seen to be occupied by concretions, with a central canal, which preserves the continuity of the vessel, and thus maintained the circulation. The stratification appears to have been very perfect.

Fig. 322.

Aneurism by Dilatation. The Abnormal Space is almost entirely filled up by Fibrin; the Arterial Canal remaining clear. Spontaneous Cure exists in an advanced stage.

A *diffused* aneurism, as it is termed, is, strictly speaking, an outgrowth of the circumscribed variety, especially of the sacciform, which, during the progress of its development, is liable to give way by the partial destruction of its sac, followed by an escape of blood. The immediate cause of such an occurrence is ulceration, gangrene, or rupture, the effect of muscular exertion, violent cardiac impulse, or severe compression. It is thus that an aneurism, originally quite small, and distinctly circumscribed, may eventually become diffused and of enormous dimensions, the blood being more or less extensively infiltrated into the surrounding tissues, separating them from each other, and thus adding greatly to the patient's suffering, as well as to his peril. This secondary occurrence usually takes place late in the advanced stage of the disease, from gradual weakening of the sac by the pressure of its contents, or by the pressure of the parts around, leading either to rupture or ulceration. Only a small quantity of blood may escape in the first instance, and, if it should coagulate very firmly, the clot so formed may, for a time, serve as an effectual barrier against further loss. Most generally, however, the effusion is great and rapid, and local suffering proportionately imminent. The newly extravasated blood is sometimes intermixed with fibrinous concretions, especially such as are of more recent formation and have not yet become firmly adherent to each other and to the sides of the sac. However this may be, it usually speedily coagulates, gradually increases in consistence, and ultimately, perhaps, even undergoes a certain degree of organization, more particularly if the patient survives the accident for any considerable length of time. Meanwhile, the structures among which the blood has been extravasated become more or less indurated, inflamed, and infiltrated with serum, while the abnormal pouch itself is incrusted with plastic matter; an arrangement evidently designed to protect the sac, and to prevent it from breaking at once through its confines. Eventually, however, if life be not worn out by pain and irritation, the tumor is sure to give way by ulceration, gangrene, or rupture, followed more or less speedily by death.

3. SYMPTOMS OF ANEURISM.

The symptoms of aneurism exhibit, as might be supposed, much diversity, the principal circumstances which influence them being the nature, seat, and age of the tumor. Hence, in order to comprehend the subject thoroughly, it must be studied with special reference to these points.

In spontaneous aneurism, usually dependent upon rupture of the coats of an artery, the patient is often apprised of the commencement of the disease by the occurrence of a sharp pain, not unlike that produced by an electrical shock; he feels as if he had received a smart blow, and, perhaps, turns to see who inflicted it. Occasionally, also, he is conscious of something having suddenly given way—he may even have heard a slight noise —and on examining the part, a small, pulsating tumor is found. Upon being interrogated as to the cause of the accident, he will usually state that it took place while he was engaged in some severe bodily exertion, as leaping, running, lifting, or coughing. But the origin of the disease is not generally thus marked; in the majority of cases, in fact, the patient has no distinct perception of its occurrence, and he is only apprised of its existence by degrees; not, perhaps, until it has already made serious progress. Such an event will be particularly apt to happen when the lesion consists essentially in a dilated condition of the arterial tunics, unattended with rupture, as it is then often extremely stealthy in its mode of invasion. In traumatic aneurism, on the contrary, the characteristic symptoms ordinarily show themselves immediately after the receipt of the injury of the vessel upon which the disease is situated.

The aneurismal tumor is usually quite small at its commencement, not exceeding, perhaps, the volume of a filbert, a small hickory-nut, or an almond; by degrees, however, it augments in size, and may ultimately acquire a bulk equal to that of a man's fist, or even of an adult's head. In its form it may be globular, elongated, ovoidal, conical, fusiform, or cylindrical; or so irregular as to defy description. However this may be, it is a living, beating tumor, rising and expanding synchronously with the contraction of the left ventricle of the heart. Its pulsations are often perceptible at the distance of a number of feet, especially in strong, plethoric subjects, and are always increased in force and frequency by whatever has a tendency to excite the general circulation. It imparts a distinct impulse to the hand, rising and falling as the blood enters and passes out; it is soft and elastic, and in its earlier stages permits itself to be emptied by steady and uniform pressure. Upon applying the ear to the tumor, a peculiar noise is perceived, differing very much in its character and intensity. In general, it is a kind of sawing, rasping, hissing, or bellows sound, so loud as to be heard with great distinctness at a distance of several inches; occasionally it is of a peculiar whizzing, whirring, or purring nature, and cases occur, although they are rare, in which it strongly resembles the buzzing of a fly in a bottle. The immediate cause of the sound is the manner in which the blood rushes into the tumor; its pitch is always greatest, other things being equal, when there is a comparatively small opening of communication, and when the sac, containing but little solid matter, is seated superficially.

The phenomena now described are generally susceptible of great modification by pressure applied to the artery above and below the tumor. In the former case, the size of the swelling is notably diminished, and all motion and noise disappear; in the latter, it is sensibly augmented, the tumor heaves and rises under the resistance, and the blood, rushing violently against the inner surface of the sac, at each systole of the heart, produces great tumult, with a corresponding increase in the intensity of the different sounds. Considerable changes in the aneurismal sounds are sometimes occasioned by the rugose condition of the margins of the orifice of communication, and by partially detached clots, or projecting filaments, within the sac, intercepting the column of blood, and causing various murmurs and vibrations, together with a tremulous shaking of the tumour, isochronous with its pulsations.

The pain attendant upon aneurism is constant, but subject to variation in its intensity; slight early in the disease, and while the swelling is still small; more severe and harassing as it progresses and encroaches upon the surrounding parts. Diversified in its character, it is generally dull, aching, and throbbing, as if matter were about to form; in some cases it is sharp and darting, in others dull, heavy, or gnawing. Occasionally it is of a neuralgic nature, coming in fits and starts, or, as sometimes happens, in regular paroxysms, once or twice in the twenty-four hours. The immediate causes of the pain are, inflammation of the sac, and the pressure of the sac upon the neighboring structures; hence, as a general rule, it is always most violent in large and old aneurisms, and in those parts of the body which are most abundantly supplied with nerves, or where there is naturally a great deal of dense, firm, unyielding structure, interfering with the development of the tumor.

For the same reason that the pressure of the tumor causes pain, the distal parts usually suffer from numbness, and a sense of aching and weariness. Their temperature is diminished, and they are weak and crippled. Great swelling, of an œdematous character, is

often present, the result, evidently, of the compression of the veins and lymphatics impeding the return of their contents. As the tumor enlarges, the distal portion of the artery contracts, and conveys less of its wonted supply to the part below it. Gradually, however, this is compensated for by the collateral vessels, which, naturally existing, augment in size, and, in time, amply atone for the diminished stream in the main trunk. If it were not for this arrangement, the parts would soon shrivel and wither, or, worse, fall a prey to gangrene. Fortunately, such an event can only happen when the aneurism is of extraordinary bulk, or of very rapid development, thereby compressing also the collateral vessels and the principal nerves.

Aneurism of the thoracic aorta, and of the innominate and carotid arteries, is nearly always attended with distressing dyspnœa, severe pain, and palpitation of the heart, which is itself often seriously implicated in the disease, being especially liable to suffer from hypertrophy, softening, and fatty degeneration, along with chronic endocarditis and disorder of the tricuspid and semilunar valves. As the tumor enlarges, the respiratory difficulty rapidly increases, rendering walking painful, and the maintenance of the recumbent posture ultimately impossible. Compression of the trachea may induce asphyxia; of the œsophagus, inanition. In the abdomen and pelvis, aneurism of the larger arteries, besides causing violent pain, may occasion serious functional disturbance, by interfering with the return of the blood in the vena cava, and thus leading to ascites and anasarca.

4. DIAGNOSIS OF ANEURISM.

Although the symptoms of aneurism are, in general, so well marked as to render it difficult to mistake their import, yet, as the disease may be simulated by other affections, and as doubts may thus arise in the mind of the inquirer concerning its true nature, it is necessary, in every case, however well characterized it may apparently be, before he comes to a final decision, to institute a faithful examination into its history, progress, and existing condition. It has been for the want of proper care in the investigation of this disease that some of the most serious and disgraceful blunders that disfigure the records of surgery have been committed; and, although such errors are now less frequent than they were formerly, owing to the more general use of the exploring needle, and a better acquaintance with pathological anatomy, yet it cannot be denied that what has occurred once may happen again, and that with tenfold effect, as it respects the character of the surgeon, who, to his skill as an operator, is always supposed to unite that of an enlightened diagnostician. The affections with which aneurism is most liable to be confounded are, chronic abscesses and different kinds of tumors, especially the glandular and encephaloid sarcoma. Attention to the following circumstances cannot fail, if carefully considered, to protect the practitioner from error.

1. Aneurism is always, from the first, seated in the direction of one of the larger arteries, whose course may often be distinctly traced by the finger; it is soft and elastic, pulsates more or less violently, is free from pain, and is unattended with discoloration of the integument. Abscess, on the contrary, begins as a hard swelling, and becomes soft only after it has passed through its different stages; if chronic, matter will form very slowly, and, although it may surround the artery, and thus receive its impulse, yet the peculiar fluctuation of the swelling, and the changes that may be induced in it by pressure and posture, will always suffice to prevent error. In acute abscess, there is severe pain, pus is poured out rapidly, and there is marked discoloration of the surface, with more or less constitutional disturbance. Glandular lymphatic swellings are most common in the neck, axilla, and groin in children and young persons of a strumous diathesis; they generally advance pretty rapidly, and, after having attained a certain bulk, either remain stationary, or alternately advance and recede; they are usually multiple, and not unfrequently occur simultaneously on both sides of the body. External aneurism, on the contrary, is most common in the popliteal, femoral, innominate, and carotid arteries in middle-aged and elderly subjects, and, progressing slowly but steadily, never recedes, and rarely exists in more than one situation at the same time. Sarcomatous growths occur at all periods of life and in nearly all regions of the body; soon acquire a large bulk; are of varying degrees of consistence, some parts being solid, some soft, and some semisolid; are attended with great enlargement of the subcutaneous veins; and soon give rise to a pale and sallow state of the features. Aneurism, as just stated, advances tardily, is of uniform consistence, especially in its earlier stages, is not accompanied by any enlargement of the subcutaneous veins, and, although the general health may seriously suffer, there is an entire absence of carcinomatous impress.

2. Aneurism pulsates the moment it is developed; no matter how small it may be, it throbs and heaves isochronously with the heart, and possesses all the characteristic traits that distinguish it in its later stages, although they are, perhaps, less strongly marked. Abscesses and solid tumors, on the contrary, are seldom affected by the beating of the underlying vessel until they have acquired some bulk, and even then the impulse is often very faint, occurring rather as an undulatory movement than as a distinct shock.

3. In aneurism the tumor is generally firmly fixed, any attempt to grasp and lift it up proving abortive; possibly, it may be pushed gently to one side or the other, but this is all. Moreover, whatever changes may be effected in its relations, none can be effected in its pulsations; it throbs and heaves as before. With solid growths this is not so; unless very large, they can readily be isolated from the vessel, and be thus deprived of all impulse, however strong.

4. The pulsation in aneurism is generally uniform, being perceived equally at every point of the circumference of the tumor, which rises and falls synchronously with the systole and diastole of the heart; in abscesses and solid growths, on the other hand, it is very irregular, and is usually limited to some particular spot. In aneurism the swelling bounds and recedes under the hand; it feels as if it were alive and panting; in solid tumors the morbid mass rises at each impulse, but there are no expansion and contraction.

5. When an aneurism is firmly and uniformly compressed, it sensibly diminishes in bulk, which, however, recovers itself the moment the hand is removed; in solid growths and abscesses, pressure produces no such effect.

6. In aneurism, the size of the swelling is diminished by pressure upon the cardiac side of the tumor, and increased by pressure upon the distal side. In morbid structures not arterial, no change of bulk follows this procedure.

7. The sounds of aneurism are different from those of solid tumors. Both may yield a sawing, bellows, or rasping noise, but in the latter this is never conjoined with the peculiar thrill, or whirring noise, which constitutes so prominent a symptom in the former.

8. Aneurism of the larger arteries ordinarily affords two alternate shocks, one of which corresponds with the diastole of the heart, the other with its systole. These phenomena are never present in solid tumors and abscesses, and are therefore pathognomonic.

When, as is sometimes, though very rarely, the case, an aneurism opens into an abscess, the ordinary phenomena, as pulsation, bruit, and thrill, are suddenly superadded to those of the latter disease, with great increase in the volume of the tumor, and more or less marked expansion of its walls. Such an occurrence is most common in the neck, axilla, groin, and ham, in consequence of chronic suppuration, and demands special vigilance for its successful discrimination.

An aneurism has occasionally been mistaken for rheumatism, and, conversely, rheumatism for aneurism. I have known the pain and swelling caused by an aneurism of the popliteal artery to be treated for rheumatism of the knee-joint; and a number of instances have fallen under my observation in which the pulsation and expansion that are so liable to accompany neuralgia of the abdominal aorta and of the innominate and carotid arteries were supposed to have been occasioned by aneurism of those vessels. Finally, aneurism may be simulated by anemia, especially when it occurs in conjunction with neuralgia, or neuralgia and rheumatism, in a person of broken-down constitution. Errors of diagnosis, under such circumstances, are generally easily avoided by a thorough examination of the part affected, and by a careful consideration of the history of the case.

Such are the distinguishing characters of aneurism and of the more important diseases with which it is liable to be confounded. It must be obvious, from what has been said respecting them, that mistakes can only be avoided by the most rigid and thorough examination, made not once, but repeatedly, in every case of tumor situated along the course of an artery and influenced by its pulsation. When, after such a painstaking process, no satisfactory decision can be arrived at, the only resource is the insertion of a delicate exploring needle, which, while it can do no possible harm, if it be properly employed, will at once determine the diagnosis.

Serious, and sometimes even fatal, accidents occur during the examination of an aneurismal tumor, either from a detachment of some of its clots, causing embolism, or from a rupture of the sac, followed by destructive hemorrhage. In a case of aneurism of the common carotid artery, the size of a hen's egg, reported by Esmarch, firm pressure upon the tumor suddenly produced symptoms of apoplexy, of which the patient died in three days; and in a similar case, recorded by Mr. T. P. Teale, of Leeds, hemiplegia was suddenly induced, ending in death in a few weeks. In both of these instances the trouble

was no doubt occasioned by obstruction of some of the cerebral arteries, by small clots finding their way into the brain. Dr. Bontecou, of Troy, several years ago, tied the external iliac artery in a case of inguinal aneurism, ruptured by the manipulations of a professional rubber, employed to relieve pain. The rude handling of an aneurism sometimes gives rise to violent inflammation of its sac, followed by gangrene and death. Facts like these should teach the surgeon the importance of great caution in his attempts at arriving at a correct diagnosis in tumors situated in or involving arteries, especially those of the neck, ham, and the abdomen.

5. EFFECTS AND TERMINATION.

The effects which an aneurism exerts upon the surrounding parts vary according to circumstances, of which the most important are, the situation of the affected vessel, and the size of the tumor. An aneurism of the arch of the aorta produces, other things being equal, more serious disturbance, both organic and functional, than one of the abdominal portion of that vessel, and an aneurism of the carotid artery than one of the popliteal. It is obvious also that a small tumor will, as a general rule, cause less serious effects than a large one.

The effects which such a disease produces upon the parts with which it is in contact are purely of a mechanical character, eventuating in their displacement, compression, or ulceration, or in all these occurrences combined. An aneurism of the thoracic portion of the aorta must necessarily encroach more or less upon the contents of the chest, pushing the heart and lungs out of their natural position, and thereby interfering essentially with the performance of their proper functions. In aneurism of the carotid artery there will be displacement of the trachea, œsophagus, and the great vessels of the neck, along with compression of these parts, and also of the pneumogastric and sympathetic nerves. In popliteal aneurism the portion of the limb below the site of the tumor generally suffers from obstructed circulation, as is evinced by the occurrence of anasarca and decrease of temperature, with a feeling of numbness, the result of interruption of the nervous current. When the embarrassment to the flow of blood is very great, or long continued, mortification of the distal portion of the limb is liable to ensue.

When the tumor is situated externally, it may produce serious changes in the muscles, which, in many cases, are not only widely separated from each other, but remarkably pale, flattened, and attenuated, exhibiting more the appearance of thin ribbons than of thick, solid, fleshy bodies. The nerves, too, are often very much spread out, the vessels are thrust aside, and the aponeuroses are stretched out like tense sheets. When pressing upon an important joint, the tumor is sure to impede its motion, and may even cause permanent ankylosis, as occasionally happens in aneurism of the popliteal artery.

The effect produced by aneurism upon the osseous tissue is sometimes very remarkable. It is generally most conspicuous in the dorsal portion of the spine. When the disease involves the thoracic aorta, the tumor, crowded into a comparatively small space, is liable, especially when it is of large bulk, to encroach seriously upon the bony walls of the chest, pressing upon and eroding the bodies of the vertebræ behind, as seen in fig. 323, the sternum in front, the ribs at the side, and the clavicle above. There is no osteological cabinet, of any extent, that does not contain specimens of this kind. I have seen cases where as many as four of the bodies of the dorsal vertebræ were completely absorbed as far as the spinal canal, which, forming the posterior boundary of the tumor, was thus freely exposed to its pulsations. The sternum suffers mostly at its lateral and upper aspect, but occasionally, as in an instance now under my care, it is perforated at the centre, the movements of the aneurism being distinctly visible at that part. The ribs and their cartilages do not generally participate to any considerable extent in the erosion, and the clavicles are rarely affected, unless the tumor is of great bulk, and projects unusually high up into the neck.

Fig. 323.
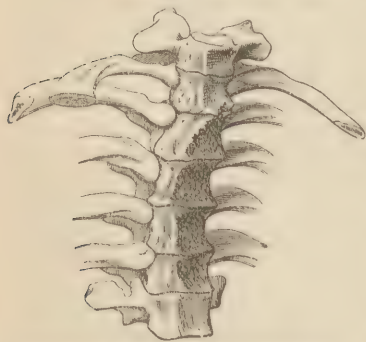
Erosion of the Vertebræ from Aneurism.

It is not surprising, after what has been said respecting the effects which aneurism is

capable of exerting upon the osseous tissue, that the tumor should occasionally cause serious lesion in the soft structures, apart from their mere compression. In its earlier stages, before the swelling has attained any considerable bulk, the inroads are slight, and, consequently, well borne, the parts manifesting no disposition to resent its encroachments; by and by, however, as it progresses, its pressure bears heavily upon the adjacent textures, which, taking on inflammatory action, become matted together by interstitial deposits, which, for a time, thus materially strengthen the aneurismal sac. But such a state of things is not destined to last long; gradually the morbid action increases, the superincumbent tissues are more and more expanded, and, at length, ulceration setting in, the integument yields over the more prominent portion of the sac, followed by destructive hemorrhage.

6. SPONTANEOUS CURE.

Unfavorable as the prognosis of aneurism generally is, it is gratifying to know that a cure is occasionally effected spontaneously, without the intervention of art in any way. That such an event is rare, forming merely an exception to the great law, is unfortunately too true; yet it sometimes occurs under circumstances, apparently, the most desperate, bidding defiance alike to medical and surgical skill. There are, indeed, few practitioners of enlarged experience who have not met with cases of this disease in which, contrary to all calculations of the doctrine of chance, the patient made an excellent recovery, after having literally hovered, for days and weeks, over the very verge of the grave; where, in short, everything portended speedy destruction, and yet every vestige of the aneurism ultimately disappeared, the person living for years afterwards in the enjoyment of good health, and in the exercise of his former occupation. How the cure is effected in these cases our information does not enable us to explain, as an opportunity is seldom afforded of making a dissection of the body after the event has taken place, in consequence of the individual being usually lost sight of. A knowledge, however, of the possibility of such a cure is highly encouraging, and holds out the hope that it may be of more frequent occurrence than has hitherto been imagined.

The most remarkable case of the spontaneous cure of this disease that I have ever seen, was that of a gentleman sixty-two years of age, whom I attended in January, 1862, along with Dr. E. L. Carter. The tumor, which had come on about twelve months previously without any assignable cause, presented all the characteristic features of an aneurism of the left subclavian artery. It occupied the whole of the triangular space above the clavicle, between the trapezius and sterno-cleido-mastoid muscles, where it formed a large prominence, heaving and pulsating synchronously with the contraction of the left ventricle of the heart, and imparting a peculiar blowing or sawing sound to the ear. The patient experienced excessive pain in the tumor, as well as in the shoulder and arm; there was great numbness of the whole extremity, and he was obliged to be constantly propped up in bed, as well as to use anodynes freely to enable him to sleep. The prognosis, in fact, could not have been more unpromising. Early in May, however, he was able to take gentle exercise in the open air; his health now gradually improved, and the tumor began to diminish in size, the process of absorption steadily progressing until December, 1863, when every trace of it had disappeared. The left arm and hand remained cold and atrophied, but in all other respects the recovery was perfect. The treatment consisted principally of the internal use of iron and quinine, along with a properly regulated nutritious diet.

Although we are not always able to account for the manner in which the patient recovers in this disease, observation has demonstrated that it generally occurs in one of five ways, all leading, essentially, to the same result, namely, the formation of clots, by which not only the aneurismal sac is closed up, but also the artery immediately above and below it. When the cure is gradual, the clots are usually arranged concentrically, and exhibit every mark of organization; but the reverse is the case when it is effected suddenly, for then they are nothing but soft, red blood-masses, similar to what are so often observable after death in the heart and large vessels.

1. The most common way in which the cure takes place is by the gradual filling up of the sac by the formation of clots, thereby ultimately converting it into a firm, solid tumor. The most beautiful and perfect specimen of this kind, sketched in fig. 324, that I have ever seen, was presented to me by an old pupil, Dr. Shumard, who had removed it from the body of a young steer. What renders it still more interesting is the circumstance that it was connected with the hepatic artery, which had given way at one side from the rupture, apparently, of its inner and middle tunics. The tumor, which is of a

rounded shape, and nearly three inches in diameter, is occupied by hundreds of lamellæ, many of them not thicker than a sheet of paper, of a pale grayish color, closely adherent to each other, concentrically arranged, of a dense, firm texture, and, beyond question, thoroughly organized, even those most recently deposited. At the centre of the tumor, a large irregular cavity exists, which still admitted some blood, as is proved by the fact that the hepatic artery is completely pervious. Such a mode of repair is greatly facilitated by the small size of the opening of communication between the artery and the aneurismal sac.

Fig. 324.

An Aneurismal Tumor obliterated by the Deposition and Organization of Fibrin.

2. Another mode of spontaneous cure is the occurrence of inflammation, followed by the coagulation of the contents of the sac, and the ultimate obliteration of its cavity as well as of the artery in its immediate vicinity. The disease may begin in the tumor itself, or be propagated to it from the circumjacent structures; if it is mild and slow, the cure may be easy and safe, but if very active, it may terminate in suppuration, and thus endanger life by hemorrhage, the matter being evacuated along with the clots before the artery is hermetically sealed by an internal coagulum.

3. The repair occasionally occurs through gangrene, either beginning in the tumor itself, or extending to it from the parts immediately around it. The blood coagulates in the sac as in an artery in ordinary gangrene, and when the sloughs separate the clots are discharged, the gap being afterwards closed by the granulating process. Such a mode of restoration must necessarily be infrequent, inasmuch as the morbid action by which it is effected generally terminates fatally.

4. The contents of an aneurism are sometimes solidified by the compression of the artery leading to it, caused either by the tumor itself or by some morbid growth in its immediate vicinity. Such a result may follow with nearly equal certainty, whether the pressure is applied to the cardiac or to the distal portion of the vessel.

5. Finally, there is a very rare mode of spontaneous obliteration, consisting in the detachment of a small clot and of its introduction into the distal portion of the artery, thereby more or less completely blocking it up. The blood, thus checked in its onward flow soon coagulates, just as in artificial compression. It was upon a knowledge of this species of spontaneous cure that the late Sir William Fergusson, many years ago, attempted to found a new mode of treatment of aneurism by breaking up the contents of the tumor by manipulation, and urging on some of the fragments into the distal communicating vessel.

When, by any of the above modes, a radical cure is effected, the tumor is gradually brought under the influence of the absorbent vessels, and is ultimately completely obliterated; or, at all events, so far reduced as to leave only a small nodule, indicative of the former site of the disease. The period required for the perfection of these changes varies from three or four weeks to as many months, according to the size of the aneurism and the state of the part and system.

Although an aneurism may occasionally get well spontaneously, or under internal treatment, such an event is entirely exceptional. The great law of the disease is death. The period at, and the mode in, which this takes place are extremely variable, and can, therefore, be pointed out only in a general manner. In aneurism of the aorta, especially in the arch of this vessel, the disease often terminates in less than three months from its commencement; in the innominate its course is generally also rather rapid, and a similar remark applies to aneurism of the primitive iliac; in aneurism, on the contrary, of the carotid, subclavian, axillary, external iliac, femoral, and popliteal arteries, the fatal event is often postponed several months longer. To these statements they are, of course, many exceptions; thus, on the one hand, we occasionally meet with an aneurism that kills in a few weeks, the tumor expanding rapidly, and, perhaps, bursting quite suddenly during a violent muscular effort; and, on the other, the disease may continue, with very little variation, as to size, for a number of years.

There are three distinct modes in which aneurism may cause death: 1. By the injuri-

ous compression which the tumor exerts upon the neighboring organs.   2. By the sudden rupture of the sac, and the occurrence of hemorrhage.   3. By the development of inflammation, suppuration, or mortification.

1. Aneurismal tumors of the neck and chest often cause death by compression of the trachea and bronchial tubes, although perhaps not so frequently as has generally been supposed, owing to the wonderful power which these tubes possess of flattening themselves so as to make room for the entrance of air into the lungs.   Indeed, I am inclined to think that death from direct suffocation, from this cause, is an uncommon event.   Great difficulty is often produced by the pressure of the sac upon the pneumogastric and phrenic nerves, and it is extremely probable that life is sometimes destroyed in this way, the more especially when the pressure is conjoined with serious lesion of the air-passages.   Finally, death occasionally proceeds from compression of the heart and lungs, interfering with the circulation and respiration; or from compression of the œsophagus, causing inanition.   In the abdominal and pelvic cavities, and also in the extremities, the danger from compression is not nearly so great, as the structures here are less important to life, as well as more disposed to yield under the encroachment of the tumor.

2. After an aneurismal tumor has attained a certain bulk, it is extremely apt to give way, as in fig. 325, either suddenly or gradually, under the impulse of the blood, or under severe muscular exertion.   Such an occurrence will be

Fig. 325.

the more likely to happen when the tumor has been of rapid growth, and especially if its interior has not been fortified by the formation of hard, organized clots, so as to increase the thickness and strength of its tunics.   It is in this manner that most of the internal aneurisms, which do not cause destruction by mere compression, ultimately terminate, the immediate cause of death being hemorrhage into some internal and contiguous organ.   Thus, in the chest the tumor usually opens into the trachea, bronchial tubes, pleura, pericardium, mediastinum, or œsophagus.   Sometimes a communication is established between the sac and the heart, between it and the pulmonary artery, or lastly, between it and the vena cava.   An aortic aneurism has also been known to burst into the spinal canal, some of the bodies of the vertebræ having previously been destroyed by absorption. In the abdomen, the tumor may break into the peritoneal cavity, or into one of the hollow viscera, as the stomach, intestine, or urinary bladder.   In the neck, axilla, groin, and extremities, an aneurism, if permitted to pursue its course, generally finds its way to the surface, very much after the manner of an abscess.

The hemorrhage succeeding to the rupture of an aneurism may be slight, as when the aperture is small or devious, or copious and destructive, as when the opening is large or straight. Most commonly, life is worn out by the frequent recurrence of the bleeding; thus, twenty ounces of blood may be lost to day, in a week twenty or thirty ounces more, and so on until the

Aneurism of the descending Aorta, burst, the Patient dying suddenly in consequence.

patient dies completely exhausted, his condition being, in the mean time, perhaps sadly aggravated by serous effusions into some important cavity.   Occasionally the aneurism gives way by a large rent, and the patient expires instantly from hemorrhage.   On the other hand, the sac may give way, and yet there may be no hemorrhage, the patient finally perishing from some other cause.   Thus, in the case of Mr. Liston, the opening which had formed between the aneurism and the trachea was clogged up with a mass of coagulum, which effectually prevented the escape of blood, death finally resulting from the irritation produced by the pressure of the tumor upon the inferior laryngeal nerve.

3. More or less inflammation attends all aneurisms; whatever may be their volume, situation, age, or character, they play the part of intruders, encroaching upon, compressing, and irritating the surrounding structures, and thus giving rise to various deposits, especially of serum and plasma.   It is by means of the latter that, as was previously stated, the sac increases in thickness and density, so as to qualify it the better to bear with impunity the impulse of the inflowing current of blood; without such an occurrence few tumors of this kind would be able to maintain themselves for any length of time, but would soon yield to the resistless pressure from within; in a word, speedy rupture of

the sac, and fatal hemorrhage, would, in most cases, be inevitable. But, although inflammation is set up for wise and beneficial purposes, the process, unfortunately, is not always kept within the strict limits required to fortify the sac and protect it against early rupture; on the contrary, many circumstances concur to provoke its increase, and to cause it to pass into ulceration, suppuration, or even mortification. Among these circumstances some are of a constitutional, others of a purely local, character; thus, mere plethora and the use of stimulating food and drink may powerfully augment the inflammation, and bring about these untoward results. In general, however, it will be found that the mechanical compression of the tumor, in consequence of the resistance offered to its extension, has more to do with its production than anything else. Sometimes a clot is accidentally detached, and thus becomes a cause of mischief. In external aneurism, the manipulation employed in examining the tumor is occasionally productive of severe inflammation, and similar effects often follow the injudicious use of the affected limb.

Suppuration of the tumor is an infrequent event. A case occurred in 1857, at the Pennsylvania Hospital, in the service of Dr. Pepper, in which an abscess had formed in connection with an aneurism of the innominate artery, and destroyed the patient, a man aged thirty-eight, by bursting into the trachea. A report, with a drawing of the case, has been published by Dr. Humphreys, in the Transactions of the Pathological Society of Philadelphia. Ulceration and mortification are more common, and are particularly liable to take place when the tumor is of large size.

Finally, aneurism may prove fatal by exciting inflammation in an important internal organ, as the lung, heart, or pleura. In popliteal aneurism, the pressure of the tumor upon the nerves and arteries below sometimes causes death from mortification of the leg and foot.

TREATMENT.

In the time of Celsus, as well as for a long period subsequently, the treatment of external aneurism was conducted in the most cruel and unscientific manner. The only operation which appears to have been known was that of laying open the tumor by a bold incision, and, after turning out its contents, applying the hot iron to the extremities of the affected artery, so as to seal up their mouths. The effect of such a procedure may easily be imagined; upon the separation of the eschar, hemorrhage was sure to take place, and in this way nearly every patient perished, either at the first onset of the bleeding, or by its frequent repetition. This miserable practice continued in vogue until the time of Antyllus, in the third century, who adopted a more scientific, although hardly a less hazardous, procedure. It consisted in freely opening the tumor, clearing out its contents, and tying the artery above and below, the ends of the vessel having previously been searched for with a probe. The sac was then stuffed with charpie, to promote suppuration and occlusion, the object being to heal the wound from the bottom. Occasionally the more adventurous surgeon took the more speedy route of extirpating the tumor, adopting a plan similar to that which is sometimes pursued at the present day in treating aneurism at the bend of the arm consequent upon venesection and other injuries. The result, too, of this operation was often most disastrous; many of the patients died of the effects of inflammation, some of secondary hemorrhage, and not a few of the shock of the amputation performed, as a dernier resort, to save them from impending destruction. To prevent these sad occurrences, and afford the sufferer a better chance of recovery, the removal of the limb was often the only expedient thought of for his relief.

The operation of Antyllus has been repeatedly performed for traumatic aneurism at the bend of the arm. Morel, of Paris, performed it in a case of carotid aneurism in the seventeenth century; Keyslére, in 1744, performed it in a case of popliteal aneurism, and Sabatier, not long afterwards, in a case of femoral aneurism. Mr. Syme, of Edinburgh, employed it successfully in aneurism of the common carotid, axillary, and internal iliac arteries, his first case having occurred in 1857. Several other surgeons have been equally daring.

a. DELIGATION OF THE ARTERY AT THE CARDIAC SIDE OF THE TUMOR.

It is very surprising that some of the procedures above described should have continued in vogue until near the close of the last century. The fact attests, more fully than any other circumstance with which we are acquainted, the low state of surgery up to that period. The merit of performing the first operation for the cure of aneurism upon strictly scientific principles is due to John Hunter. From having witnessed so

many failures from the ordinary methods, he was led to the conclusion that the cause consisted in the fact that the artery is always diseased for some distance above the aneurism, and that it was, therefore, incapable of becoming sufficiently occluded prior to the detachment of the ligature to prevent hemorrhage. Acting under this conviction, amply confirmed by dissection and observation, he determined, upon the first favorable opportunity, to apply the ligature to a sound portion of the vessel. While thus revolving the matter in his mind, a man, laboring under popliteal aneurism, was admitted into St. George's Hospital, of which he was then one of the surgeons. The patient was a coachman, forty-five years of age; and the tumor, first perceived three years previously, was not only quite large, but attended with great swelling of the foot and leg. The operation was executed in December, 1785, the femoral artery being exposed a little below its middle, and surrounded by four ligatures drawn so gently as simply to bring the sides of the vessel together. "The reason for having four ligatures was," as is stated by Sir Everard Home, by whom the case was reported, "to compress such a length of artery as might make up for the want of tightness, it being wished to avoid great pressure on the vessel at any one part. The ends of the ligature were carried directly out of the wound, the sides of which were now brought together and supported by sticking-plaster and a linen roller, that they might unite by the first intention."

It is unnecessary to enter into any details respecting the after-treatment of the case. It will be sufficient for my purpose to state that on the second day after the operation the tumor had lost more than one-third of its original bulk; that the ligatures, some of which came away on the fifteenth day, excited severe inflammation in the artery, as well as in the surrounding parts; and that the man left the hospital on the 8th of July following, in good health, and with no appearance of any tumor in the ham. He subsequently resumed his former occupation as coachman, and died from an attack of remittent fever, fifteen months after the operation. The limb being dissected, the femoral artery was found to be impervious as high up as the profunda, while below the site of the ligatures, as far down as the tumor, it was open, and contained blood, except just where it entered the aneurism, where it was obliterated. The sac was a little larger than a hen's egg, but more oblong and flattened, and contained a solid coagulum adherent to its internal surface.

I have been induced to give a brief outline of this case for two reasons. In the first place, it deserves to be commemorated because it embodies the application of a new principle to the cure of a disease which, until then, was almost uniformly fatal; and, secondly, because it will enable us to establish, in a more satisfactory manner than we could otherwise do, the claims of Mr. Hunter to the credit of having originated the operation, which has been so sturdily denied him by the French surgeons, who have, almost with general consent, ascribed it to their countryman, Dominic Anel.

The case of Anel, which occurred at Rome in 1710, was that of a priest, who, from a prick of the brachial artery received in venesection, had an aneurism at the bend of the arm; the tumor was large, and apparently on the point of bursting. Having controlled the circulation in the limb by means of the tourniquet, he cut cautiously down upon the artery, and, after separating it from the accompanying nerve, raised it upon a hook, and tied it as near to the tumor as possible. All pulsation instantly ceased, the ligature came away on the eighteenth day, and at the end of a month the friar was able to use his arm as well as ever.

It will thus be perceived that the operations of the English and French surgeons differed from each other in every particular; and it is only surprising that there ever should have existed any contrariety of opinion respecting them. The procedure of Anel was executed for the cure of a traumatic aneurism; the artery was perfectly healthy, and it was tied as closely to the tumor as possible. He never supposed that he was about to establish a new principle in surgery; he nowhere alludes to any such intention; his only object seems to have been to afford his patient, who was suffering great agony, and who might bleed to death at any moment from the sudden bursting of his tumor, prompt relief. Hunter, on the contrary, had studied the subject with extraordinary care and attention; he had made numerous dissections, and even performed some experiments upon the inferior animals, as the dog and horse, with a view of ascertaining the condition of the artery in aneurism, and its ability to bear the ligature; and he had clearly perceived that, as the cause of failure of the old operation was that the ligation was always made too near to the tumor, the only safety would be to tie a sound portion of the vessel, even although this should be at a very considerable distance from the aneurism. His object was not to cut off the supply of blood at once, but simply to weaken its passage through the tumor, thereby giving its contents an opportunity of undergoing gradual coagulation, and at

the same time preventing the distal parts of the limb from perishing from the sudden stoppage of the circulation. The result of the case above detailed proved the correctness of his reasoning, and established, upon a firm and immutable basis, what is now universally recognized in Great Britain and in this country as the Hunterian operation for aneurism.

The operation of Hunter has been performed upon almost every artery of the body liable to suffer from aneurism. Even the aorta itself has repeatedly been tied; and, although all the cases have proved fatal, yet the result has been such as to show, most conclusively, that the event has been due much more to the injury inflicted upon the surrounding structures than to the violence done to the circulation by cutting off so great a quantity of blood from its accustomed channels. Remarkable simplicity now characterizes the operation; a healthy portion of artery is selected, great care is taken, in exposing the vessel, to disturb its sheath as little as possible, and only one ligature is used, but that is drawn so tightly as to divide the inner and middle tunics, when, a double knot being made, one extremity is cut off, and the other is brought out at the nearest point of the wound, which is then treated in the ordinary manner. In separating the artery from its accompanying vein or veins, the greatest possible care must be taken not to inflict any injury upon these vessels, as this would not only embarrass the operator, but might lead to severe phlebitis, and even mortification, especially in aneurism of the lower extremity. The procedure may generally be materially expedited and its safety insured by the cautious use of the grooved director, aided by dissecting forceps and the finger-nail.

Cessation of pulsation usually occurs at once upon tightening the ligature, although not necessarily so; sometimes, indeed, several days elapse before it is fully established, but even then it is commonly very much diminished in force, thus paving the way for the gradual formation of clots upon which the cure ultimately depends. The persistence of the circulation, after the main artery of a limb has been ligated, arises from the anastomosing branches continuing to pour their contents into that portion of the vessel which lies between the cord and the sac, as well as into the sac itself, and, perhaps, also into the distal portion of the artery. When these branches are inordinately large, or numerous, they may keep up such a supply of blood as to compromise effectually the success of the operation.

More or less pain usually attends the tightening of the ligature round the artery, if the patient is not under the influence of an anæsthetic. It is occasionally very severe; and cases occur, as when a nervous filament is included in the cord, in which there is a sense of tingling and of numbness.

The operation is generally followed by a slight diminution of temperature in the limb, but this rarely lasts beyond a few hours, when it is succeeded by a marked increase of heat, owing to the augmented activity of the cutaneous circulation, in consequence of the blood being forced principally through the superficial capillaries. Subsequently, however, as the anastomotic branches enlarge, and the circulation becomes equalized, the temperature sinks again, and now, perhaps, somewhat below the normal standard, the parts really feeling, for the first time, the loss of blood occasioned by the ligation of the artery. In not a few cases the limb retains its temperature after the operation with hardly any variation, as if nothing at all had happened.

Instead of using the ordinary silk ligature, Dr. Stone, of New Orleans, in 1859, in a case of aneurism, tied the common iliac artery with a silver wire, simply approximating the sides of the vessel, and leaving the wire in the wound, convinced of its entire harmlessness. The patient died on the twenty-sixth day, but, as no autopsy was made, the disposition of the ligature was not ascertained. At the Clinic of the Jefferson Medical College, in 1861, I secured, in a similar manner, the femoral artery in a case of popliteal aneurism; the patient rapidly recovered without any untoward symptom, and the wire still remains in the thigh, nearly the entire wound having healed by the first intention. Since that period I have operated, equally successfully, with the metallic ligature upon four other cases, the last of which concerned the external iliac. Dr. Bozeman, of New York, in 1867, tied the common carotid with the silver wire, and other vessels have been thus secured by other surgeons.

Experiments made upon the lower animals, on the ligation of arteries with silver wire, by Dr. B. F. Howard, of New York, fully substantiate the results obtained from its employment in the human subject. He has shown that when the wire is drawn tightly, it causes not only death of the portion of the artery embraced by it, as after ligation with a silk thread, but that the loop is cast off, and is either discharged at the surface, or becomes

encysted at some distance from the point of application. He, therefore, concludes that silver wire is not an innocuous material if the internal and middle coats of the artery are severed, but that, when applied so loosely as merely to obstruct the flow of blood through the vessel, it remains permanently at the point where it is placed, thereby greatly diminishing the risks of secondary hemorrhage.

In ligating an artery in its continuity for the cure of aneurism, the greatest possible care must be taken not to wound the accompanying veins, as such an accident inevitably endangers the issue of the case by provoking a bad form of phlebitis, from the effects of which few persons recover. The ligature, passed through the vessel, embraces a portion of it tightly along with the artery, and, consequently, acts precisely as a seton, causing diffusive inflammation not only in the vein itself, but also in the surrounding structures. The risk will be particularly great when an artery is tied close to the aneurism, as, during the progress of this disease, the inflammation of the sac not unfrequently extends along the connective tissue which connects the two vessels, thus rendering them specially intolerant of interference. When such an accident happens, the ligature must at once be withdrawn, and repassed with more care, either at the same point or a short distance above or below. The bleeding is not always easily arrested by compression.

However executed, the operation should never, if possible, be undertaken without some preliminary treatment. For a week or so previously, perfect rest both of the part and system should be enjoined, the diet should be carefully regulated, and proper attention should be bestowed upon the bowels and secretions. If there be any doubt in regard to the establishment of the collateral circulation, this desirable object should be promoted by compressing, for a few hours daily, the main artery of the limb. Mr. Charles H. Todd, of Dublin, in a paper on aneurism published in 1822, strongly insisted upon this mode of treatment, and expressed his conviction that, when neglected, the operation must often be followed by mortification and other bad consequences from the want of a due supply of blood in the distal portion of the limb after the application of the ligature. Compression, under such circumstances, would have the additional effect of favoring the solidification of the contents of the sac.

Mr. Syme suggested that, in aneurism of the carotid, axillary, gluteal, and iliac arteries, in which the Hunterian operation is not admissible, the sac should be freely opened, and, after evacuating its contents, the artery should be sought for, and tied above and below. In several instances in which he adopted this procedure, his efforts were crowned with complete success. The last case to which he applied it was one of aneurism of the external iliac, in which, after ripping open the sac to the extent of six inches, and turning out six pounds of blood and fibrin, he secured not only this vessel but also the common and internal iliac arteries, and had the satisfaction of saving his patient. Very little suppuration took place. Such operations are replete with interest, as showing the skill and daring of the surgeon, and the astonishing powers of endurance of the system, but are hardly to be held up as examples for general imitation.

Two grave objections may be urged against the adoption of this procedure. In the first place, the artery in the immediate vicinity of the aneurism is often so much diseased as to render it incapable of sustaining the slightest pressure of the ligature; and, secondly, it is frequently no easy matter to expose the vessel, owing to the manner in which it is overlapped by the expanded sac. Moreover, the sac, especially when of large size, is often fed by a number of arteries, the bleeding of which it would be extremely difficult to control by any mode of management that can be devised. The plan, however, should not, on these accounts, be entirely rejected, for it is easy to perceive that circumstances might arise where it would afford the only chance of safety. Many years ago, I operated upon a case of aneurism of subclavian artery, where, nearly one month after the ligation of the vessel, the sac burst into the chest and occasioned fatal pleurisy. If such an event could have been foreseen, the opening of the sac, and the evacuation of its contents, might have saved the patient's life.

In tying deep-seated arteries, especially those at the root of the neck, great advantage may often be derived from throwing reflected light, with the mirror of an ophthalmoscope, into the recesses of the wound. No operation of this kind should be performed on a cloudy day; and, after the division of the integument and muscles, the knife should be used as little as possible.

After-treatment.—The treatment after the Hunterian operation must be conducted with great judgment and attention. The patient being carried to bed, the limb is placed in an easy and relaxed position, but not elevated, lest arterial influx be interfered with; and

it will be well, especially if there be a diminution of temperature, to envelop it in cotton or flannel, aided, if necessary, with bottles of hot water, until it regains its natural warmth.   Cold applications must be carefully avoided, even if the skin is hot and swollen, as they tend to lower the vital powers, and so predispose to mortification.   A full anodyne should be administered immediately after the operation, to relieve pain and tranquillize the action of the heart; light diet, with cooling drinks, should be enjoined; and the temperature of the apartment should not be permitted to exceed 65° of Fahrenheit.   The bowels must not be opened for several days, and then only by the mildest laxatives, drastic purgatives being particularly objectionable on account of their tendency to cause excitement and throbbing of the arteries; occurrences which would inevitably be injurious after such an operation.   All bodily and mental exertion should be studiously guarded against for several days after the separation of the ligature, lest, the feeble adhesions giving way, secondary hemorrhage ensue.

Causes of Failure.—The causes of failure after the Hunterian operation are, first, violent inflammation, followed by mortification; secondly, death of the limb from deficiency of blood; thirdly, secondary hemorrhage, either from premature detachment of the ligature, or rupture of the sac; and, fourthly, maintenance of the circulation by means of a redundant anastomosis.

Ligation of an artery is not often followed by severe *inflammation* at the seat of the operation; the parts, indeed, frequently, if not generally, unite by the first intention, or, if there is any suppuration, it is chiefly at the seat of the ligature.   It is only, or mainly, in persons of bad constitution that the resulting action is apt to run riot, or to assume an erysipelatous character, threatening limb and life.

Mortification of the limb below the seat of the operation, from inflammation and defective circulation, is met with almost exclusively in the inferior extremities after ligation of the femoral artery for aneurism of the popliteal.   Of 156 cases of this operation, analyzed by Dr. Norris, 28, or about $5\frac{1}{2}$ per cent., were followed by this accident.   Of these cases, 11 died and 7 recovered, 6 of the latter having escaped with the loss of the affected limb.   The probability is that gangrene may arise from a mere want of blood in the parts, but most generally it is dependent upon inflammation of the artery leading to the formation of fibrinous clots, and the consequent closure of the caliber of the vessel and also of some of the collateral channels.   The mortification usually begins within the first forty-eight hours in the distal portion of the limb, from which it gradually spreads until the patient dies, as he usually does in from five to ten days after the first appearance of the disease.

The best means of averting this untoward occurrence is to place the limb in a proper position and to guard against overaction in the parts.   If gangrene manifest itself, notwithstanding our endeavors to prevent it, amputation must at once be performed, the limb being, if possible, removed above the seat of the aneurism.

Secondary hemorrhage after this operation is most liable to occur about the time of the separation of the ligature, but it may come on before or it may not take place until much later.   In general, it supervenes from the seventh to the eighteenth day.   A diseased state of the artery, excessive inflammation, or the malapplication of the ligature, may be considered as so many exciting causes of the accident.

The frequency of secondary hemorrhage after the Hunterian operation has been differently estimated by different writers.   Lisfranc collected 180 cases, of which 32 were followed by this occurrence.   In 530 cases analyzed by Porta, secondary hemorrhage took place in 73, of which more than one-half perished, either directly or indirectly from loss of blood.   If we descend to particular operations, it will be found that of 38 cases of ligation of the carotid there were 7 cases of secondary hemorrhage, with 2 cures and 5 deaths; the external iliac affords 8 cases out of 97, of which 5 died and 3 were cured. Of 187 operations upon the femoral artery, 19 were followed by hemorrhage, and of these 9 died and 9 were cured, the other recovering after amputation, rendered necessary on account of the persistence of the bleeding.

The principal remedies for secondary hemorrhage, after such an operation, are gentle but systematic pressure at the site of the bleeding, and also over the main trunk of the vessel, assisted by the internal use of acetate of lead and opium in union with ergot and aconite.   Occasionally it will be necessary to tie the artery higher up; or even to amputate, especially if, when the surgeon is called to the case, the loss of blood has already been great, and the parts are much obscured from swelling and infiltration.

Rupture of the aneurismal sac is uncommon after the operation.   It is observed chiefly in cases of long standing, where interference has been delayed on account of the neglect

of the surgeon or the obstinacy of the patient. The rupture may be caused either by the gradual absorption and attenuation of the sac, aided, perhaps, by the pressure of some bony prominence, or it may be due solely to the effects of inflammation. In the latter case, which is by far the more frequent of the two, the accident generally occurs at a comparatively early period after the operation, and is always preceded by well-marked local and constitutional symptoms, indicative of the impending mischief.

This accident hardly admits of satisfactory treatment. When the aneurism is favorably situated, the best plan is to lay it freely open, and to secure the main artery leading to it above and below the tumor. When this is impracticable, the chief reliance must be upon well-adjusted pressure, assisted by cold applications, Monsel's solution, and other means tending to moderate the force of the circulation.

A return of *pulsation* in the aneurismal sac, an occasional occurrence, is commonly due to a redundant collateral circulation, or an anomalous arrangement of the main artery leading to the tumor, as, for example, the high division of the femoral. In some cases it continues after the application of the ligature; in general, however, it comes on at a variable period, and now and then an instance arises in which it reappears several times during the progress of the after-treatment. The pulsation usually ceases spontaneously, followed by the gradual shrinking of the sac. When it continues obstinate, and the tumor either retains its former bulk or progressively enlarges, the remedy most likely to be successful is steady compression both of the aneurism and of the main artery of the limb. In popliteal aneurism, forced flexion of the leg might be tried.

None of these accidents, save the last, and that is a very improbable one, will be likely to happen if the part and system have been thoroughly prepared for the operation, if the disease has not made too much progress, and, finally, if proper care and judgment be employed in managing the case after the application of the ligature. Deligation of the carotid arteries for the cure of aneurism is liable to be followed by inflammation of the brain and lungs, with softening of the former of these organs and hepatization of the latter. Much of the mortality from the operation is attributable to these diseases. Cases have occurred in which this operation was followed by erysipelas, phlebitis, pyemia, tetanus, and apoplexy, but such results are extremely rare, and scarcely deserve to be taken into account in connection with it.

The subjoined table shows that the mortality after the Hunterian operation is truly frightful; a circumstance which should induce every one to regard it with suspicion and distrust.

Arteries.	Cases.	Deaths.	Per cent.
Innominate.	14	13	92.85
Subclavian	124	59	47.58
Carotid	106	37	34.90
Abdominal aorta	8	8	100.
Common iliac	32	25	78.1
Internal iliac	7	3	42.8
External iliac	126	35	27.77
Femoral	278	105	37.76
Total	695	285	41.

It is almost needless to state that such an operation should never be performed when the case is attended with great disorder of the general health, serious disease of an important internal organ, as the heart or lungs, or the coexistence of aneurism in any of the larger vessels, more especially if the concomitant lesion has already made unusual progress. Particular inquiry should always be made into the condition of the kidneys; for there is hardly any affection which exercises so prejudicial an influence upon recovery as albuminuria. Pregnancy is no bar to the procedure; and several instances have been reported in which the patients made an excellent recovery, and lived for a considerable period, after the deligation of a large artery for the cure of an aneurism complicated with aneurism of the arch of the aorta.

b. DELIGATION OF THE ARTERY AT THE DISTAL SIDE OF THE TUMOR.

It is well known that aneurism occasionally occurs so near the trunk as to render it impracticable to perform the Hunterian operation, or that the artery, although accessible at the cardiac side of the tumor, is too much diseased to support a ligature. Brasdor, of Paris, nearly a century ago, suggested the idea that gradual and efficient coagulation of the blood in the aneurism might be produced by placing the cord upon the artery

at its distal aspect. He had no opportunity, however, of solving the problem upon the human subject. The merit of this was reserved for Deschamps, although the case upon which he tried it could hardly have been worse for such an undertaking. The patient, besides being old, was worn out by suffering, and the tumor, which occupied the upper part of the thigh, extending to within a short distance of Poupart's ligament, was nearly seventeen inches in circumference. The operation was tedious and difficult, on account of the depth of the artery and the absence of pulsation, but the vessel was at length discovered and effectually secured. Contrary, however, to expectation, the aneurism, which had not made any marked progress for some time previously, now rapidly increased in volume, and on the fourth day, when it appeared to be on the point of bursting, it was resolved to perform the ordinary operation, notwithstanding the reasons which had just before been urged against its adoption. Two ligatures were applied, but the operation was attended with copious hemorrhage, and the man died at the end of eight hours.

The operation of Brasdor was next performed by Sir Astley Cooper, in a case of aneurism of the external iliac artery, extending so high up into the abdomen as to render it impossible to place a ligature between it and the heart. The femoral artery was, therefore, tied a short distance below Poupart's ligament, between the epigastric and profunda. The patient did well for some days, when the tumor, which had been gradually diminishing in volume, burst, causing death by hemorrhage.

What the results of these two efforts might have been, if the cases had been of a more favorable character, is a matter which must, of course, be left to conjecture. It is certain, however, that no attempt was made to repeat the operation until 1825, when, almost forgotten by the profession, it was performed by Mr. James Wardrop, of London, in a case of aneurism of the carotid artery. The success was complete. The ligation was followed by an immediate diminution of the tumor, which gradually progressed until, at the end of the fifth week, the neck had nearly regained its natural form; the ligature had dropped off, and the general health was entirely reëstablished. The patient, a woman, seventy-five years old, continued to be perfectly well three years after the operation.

Having been equally successful in several other cases, Mr. Wardrop was induced to extend the principle of Brasdor's operation to aneurism of the innominate artery. It

Fig. 326.   Fig. 327.   Fig. 328.
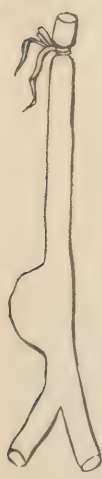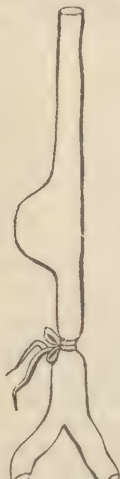
Hunter's.   Brasdor's.   Wardrop's.

occurred to him that, by tying one of the branches of this artery, the force of the circulation might be so far diminished in the tumor below as to cause the solidification of its contents. The patient upon whom he performed this operation was a woman, forty-five years of age, who had a pulsating swelling, of the size of a turkey's egg, in the inferior part of the neck, its base being concealed by the sternum, and evidently connected with the innominate artery. For the cure of this disease the right subclavian was tied in July, 1827, with the effect of a gradual amelioration of the distressing symptoms, and the ultimate disappearance of the tumor, its site being occupied merely by an unnatural hardness, the result, probably, of the remains of the aneurism. This was the condition of the patient fourteen months afterwards, at which time the carotid artery still pulsated, although not so vigorously as the left, and the woman was in better health than she had been for a long time.

The procedure now described constitutes what is called Wardrop's operation, although it is in reality, as was before intimated, merely an extension of that of Brasdor; and is only applicable to aneurism of the innominate artery. It has been performed within the last thirty years in a considerable number of cases, generally by tying the common carotid; but the results have, for the most part, been unfavorable, owing, as has been alleged, and as is probably the fact, to the occurrence of violent inflammation both in the aneurismal sac and in the vessels in immediate communication with it, terminating fatally in a few days, or, at most, in a few weeks.

Looking at the statistics of deligation of the artery at the distal side of the sac, however performed, we find that of 84 cases, death speedily occurred in 42. The majority of the patients who recovered were greatly benefited, and in not a few life was prolonged for several years.

The annexed cuts afford an illustration of the various methods of ligating arteries for the cure of aneurism, above described. A glance will serve to show how inefficient such an operation must be when performed according to the plan suggested by Mr. Wardrop.

c. INSTRUMENTAL COMPRESSION.

The treatment of aneurism by compression dates back to a very early period of the profession, and, although the principles upon which it was formerly conducted were far from being scientific, numerous cases have been published illustrative of its efficacy. It is not my design to inquire into the history of the operation, or to seek out its inventor for the purpose of awarding him praise for his ingenuity and enterprise; it is sufficient to state that the compression was originally applied directly to the tumor, or to the tumor and the limb upon which it was situated, either by means of an apparatus specially constructed for the object, or by a compress and roller, extended from the distal portion of the extremity upwards, beyond the seat of the disease. The practice was most frequently employed for the relief of traumatic aneurism, particularly that form of it consequent upon injury of the brachial artery, at the bend of the arm; and, although it proved occasionally successful, in not a few cases, it was followed by violent inflammation of the sac and limb, eventuating in ulceration, abscess, or gangrene.

The compression may be direct or indirect; that is, it may be applied either to the swelling itself, or to the artery upon which the swelling is situated. Aneurisms of various arteries, as the carotid, subclavian, brachial, iliac, femoral, and popliteal, were successfully cured by the former method by Fabricius, Tulpius, Acrel, Petit, Platner, Guattani, Ciniselli, Brunker, and many others; and, although the treatment is now obsolete, there is no doubt that it might still occasionally be advantageously employed, especially in tumors of small size. The compressing agents were generally pieces of sponge, agaric, or linen, confined by adhesive strips and a roller. Sometimes the pressure was rendered more firm by the interposition of a solid substance, as sheet lead, papier-maché, or sole leather. Dionis refers to a case in which a man cured himself of a false aneurism at the bend of the arm by keeping up gentle pressure upon the tumor for a year with a cushion.

In the latter part of the last century, Vernet, a French military surgeon, conceived the idea of curing aneurism by applying compression upon the artery immediately beyond the tumor, upon the same principle as that upon which Brasdor soon after suggested the use of the ligature. He thought that the operation was particularly adapted to aneurism situated so near to the trunk as to forbid a resort to the ligature, or compression upon the cardiac side of the swelling. It would appear, however, that he practised it only in one instance—upon a man affected with inguinal aneurism—and that so great was the disturbance which it created in the pulsation of the sac, that he was obliged, in a very short time, to abandon it. From the want of success attending the case, ill adapted as it was to test the principles of a new process, no one, it seems, felt afterwards disposed to make further trial of it, and it was accordingly forgotten, or remembered only as an ingenious sugestion.

The late Dr. J. M. O'Ferral, of Dublin, was a warm advocate of compression of the artery both above and below the tumor, or at its cardiac and distal aspects, and the signal success which attended the operation in three cases thus treated by him affords a strong argument in favor of its general adoption. As the coagulation of the blood in this method of treatment is the great desideratum, it is reasonable to conclude that it will be more rapidly effected when the compression is applied at two points than one, the blood within the tumor being thus brought more thoroughly and promptly into a state of repose so favorable to the accomplishment of the object.

Compression of the artery above the tumor, or between it and the heart, was first distinctly insisted upon as a remedy for the cure of this disease by the late Mr. Freer, of Birmingham, in his observations on aneurism, published early in the present century. In the work here referred to, he gave special directions for applying the compression, enjoining that it should be made by enveloping the whole limb with a bandage, and placing upon the vessel, in the most superficial portion of its extent, a small pad, which was then to be screwed down by means of a tourniquet. To render its action more

effective, a plate was secured to the opposite side of the limb, which, while it defended the integument and muscles from injurious constriction, concentrated the force upon the particular point of the artery where it seemed to be most needed. Notwithstanding this precaution, the application of the tourniquet was soon followed by pain and œdema of the extremity, generally so violent as speedily to necessitate its removal. Short, however, as the compression was, it occasionally laid the foundation of a cure, which was afterwards perfected by the steady but cautious use of the ordinary compress and bandage.

Acting upon the suggestions of Freer, Dupuytren and others applied themselves to this mode of curing aneurism, devising useful and ingenious instruments as substitutes for the more clumsy contrivance above described. The French surgeon, in particular, invented a most admirable compressor, at once simple and efficient, which still bears his name, and which he employed successfully in several cases of aneurism of the inferior extremity. The cures, however, that were effected in this way were few compared with the great number of failures, and the consequence was that the treatment never met with much favor. What added to the dissatisfaction of practitioners was that, in quite a considerable number of cases, it was followed by results highly prejudicial to the limb, if not both to limb and life.

Thus stood the treatment of aneurism by compression, when, in 1843, it was destined to experience a complete revolution in the hands of several eminent surgeons of Dublin, particularly Hutton and Bellingham, the latter of whom, in a short tract upon the subject, was the first to point out, upon correct and scientific principles, the manner in which it acts in curing the disease. Prior to this period, one replete with interest to the progress of surgery and humanity, compression was a very painful and hap-hazard proceeding, conducted without any discrimination and judgment, and, consequently, without any certainty as to its results. The idea was that, in order to succeed, it was necessary that it should be applied firmly and steadily, so as to arrest the circulation, and cause adhesion of the sides of the artery, very much as in the operation of ligation. Hence the poor patient was generally subjected to immense torture, often compelling the speedy discontinuance of the treatment, which, however, notwithstanding this, was occasionally followed by the worst consequences, as manifested in the violent swelling of the affected limb, and perhaps its ultimate loss by gangrene. The procedure was altogether a blind one, and, therefore, just as likely to prove prejudicial as useful. It was employed by one practitioner simply because it had occasionally been employed successfully by another, and not because any one had, as yet, been so fortunate to lay down any broad and definite rules of action. It was for this reason that it was so long in acquiring the confidence of surgeons ; that it was totally abandoned at one time, and resumed, with doubts and misgivings, at another. Its principles were not yet fully developed, or placed upon a just and comprehensive basis. This labor was performed by Dr. Bellingham and his able associates, who thus created a new era in the treatment of aneurism, hardly less brilliant than that of the ligature. What the ultimate fate of this treatment will be, time alone can determine ; that it is destined to supersede entirely, as some have predicted, the use of the ligature, is extremely questionable, and yet, considering the remarkable success which has attended it, such an occurrence seems not improbable.

Compression, as now conducted, is not only safe, but comparatively free from pain ; and, although it is often tedious, yet few cases will ultimately resist its influence. It is more especially applicable to the cure of popliteal aneurism, in which its greatest triumphs have hitherto been achieved, but it has also been successfully employed in aneurism of the femoral artery, both in its upper and lower extent, and in aneurism of the brachial artery, particularly at the bend of the arm. It is applied upon a sound portion of the vessel, at the cardiac site of the tumor, and generally at a considerable distance from it ; gently and intermittently, not firmly and persistently as in the old method ; just sufficiently to retard and weaken the circulation in the sac, not to arrest it, and so as to favor the gradual formation of clots ; allowing time for the development of the collateral vessels, and the maintenance of the nourishment of the distal portion of the member. Occlusion of the artery at the site of compression is not wished for ; on the contrary, it is desirable that the vessel should remain pervious, and retain as many of its normal properties as possible. As the stratification of the sac proceeds, as layer after layer of fibrin is deposited and becomes firmly cemented to that which preceded it, the hollow pouch is gradually filled up, and usually, along with it, also the upper orifice of the artery. To this rule, however, there are occasional exceptions, the blood continuing to flow from the artery in a

direct stream across the sac in a sort of ditch, groove, or
narrow channel.

For the purpose of making the compression, various in-
struments have been devised, one of the most simple and
efficient of which is represented in fig. 329; it is a modi-
fication of that of Charrière, and was successfully employed
by one of my former assistants, Dr. Thomas P. Gibbons,
in a case of aneurism of the popliteal artery. It consists
of a long, wide, concave, steel plate, supporting three semi-
circles of the same metal, arranged in two segments, which

Fig. 329.

Gibbons's modification of Charrière's
Compressor.

slide upon each other, and are connected each at their free extremity with a screw and
pad. The whole construction of the instrument is such as to enable the surgeon to regu-
late the pressure with the greatest nicety; making it more or less firmly, and at one or
more points, or alternately at different points, as circumstances may seem to require. The
annexed drawings, figs. 330, 331, and 332, are added for the purpose of enabling the

Fig. 330.

Carte's Compressor for the cure of Femoral and Popliteal Aneurism.

Fig. 331.

Hoey's Clamp.

reader to avail himself of the use of other compressors, if the one here described should
prove inadequate. A compressor, almost identical with Hoey's clamp, will be found de-
scribed in the sixth volume of Mr. Benjamin Bell's Sur-
gery, published in 1788. It was invented by Mr. James
Moore, of London, and was originally designed as a com-
pressor of the principal nerves of the extremities, as a
means of preventing pain in amputations.

It will generally be well, if the patient is at all intelli-
gent and trustworthy, to instruct him in the use of the
instrument, so that he may regulate the compression ac-
cording to its effects; lessening it if it is productive of
pain, and conversely.   •

One important principle in the treatment is to com-
press the artery against the bone, as a point of support;
if the pressure is widely diffused, it will only serve to
embarrass the venous circulation, and to retard the cure.
The preliminary treatment should be the same as in the
Hunterian operation; and during the progress of the
cure the limb should be kept constantly bandaged from
its distal extremity upwards, to support the capillary
vessels, and thus prevent œdema. Strict quietude, both

Fig. 332.

Carte's Circular Compressor.

of mind and body, should be observed; the diet should be mild but sufficiently nutritious;
and free use should be made of aconite, opium, and acetate of lead, as suggested under

the head of the treatment of internal aneurism. If the case is very protracted, and the health is likely to suffer from the consequent confinement, gentle exercise may be permitted in the open air, the instrument being worn several hours in the morning and evening. If any considerable swelling arise in the limb, all treatment must be temporarily suspended, and measures adopted for the relief of the morbid action. To continue the compression under such circumstances would be to jeopard the safety both of the part and patient.

The period at which a cure may reasonably be looked for in this treatment is subject to much diversity ; in some instances compression for a few hours has sufficed to produce this event ; in others, and these embrace the great majority of cases, a number of days are required ; occasionally several weeks elapse ; and examples have been reported where the stratification and obliteration of the sac were not completed under two months. As a general rule, it may be assumed that, other things being equal, the cure will be more rapid in proportion to the small volume of the tumor, the tolerance of the part to compression, and the absence of complications.

Within the last few years the old method of treatment of aneurism by forced or steady, persistent compression has, with some modification, been revived, and is likely, in great degree, if not entirely, to supersede the gradual method, upon which, until recently, so much stress was laid. The credit of recalling attention to this plan of treatment is mainly due to Dr. William Murray, of Newcastle on-Tyne, who, aware of the great pain attending it, accompanied its employment with the administration of chloroform, thus paving the way to a new application of this invaluable anæsthetic agent. His case was one of aneurism of the abdominal aorta in a man twenty-six years of age. The tourniquet was applied to the vessel above the tumor on two distinct occasions, at an interval of three days ; on the first for two hours, without any material impression, and on the second for five hours, followed by the complete arrest of pulsation, and a rapid cure. The man survived the operation, performed in 1864, six years, when, dying from the effects of another aneurism of the aorta, an opportunity was afforded of verifying the correctness of the previous diagnosis, so that no doubt could be entertained about the success of the treatment.

Since the publication of Dr. Murray's case, a number of other examples, with equally gratifying results, have been reported by other observers. Thus, Dr. E. D. Mapother, of Dublin, in a case of ilio-femoral aneurism, succeeded in effecting consolidation of the tumor in four hours and a half, by compressing the common iliac artery. In another case—one of popliteal aneurism—the time occupied in arresting the pulsation was ninety-seven hours, although pressure was applied both at the proximal and distal sides of the tumor, the limb having previously been elevated and bandaged to interrupt the return of venous blood, and direct pressure made upon the sac with an elastic roller. Dr. Heath, of Sunderland, cured an aneurism of the external iliac artery by compressing the abdominal aorta for seven hours ; Mr. Lawson was successful in a case of inguinal aneurism by pressure continued for four hours ; and in another case consolidation was effected in twenty minutes. In a case reported by Mr. Russell, a cure took place in a few hours. In all these instances the use of chloroform was conjoined with the compression. That the exhibition of this anæsthetic, however, is not at all essential to success, although generally of inestimable service in preventing suffering, and thus rendering the patient comparatively comfortable during the treatment, is proved, first, by the case of Mr. Tait, in which he effected a cure of an inguinal aneurism by compression of the aorta partly with and partly without the aid of chloroform ; and, secondly, by one by Mr. Bannon, in which a popliteal aneurism was consolidated in six hours under the stupefying influence of a large opiate. In the case of a negro, twenty-seven years of age, recently under my care in the Jefferson Medical College Hospital, I succeeded in effecting consolidation of the contents of a femoral aneurism in four hours by compressing the common femoral artery with two bags of small shot, each of which weighed five pounds, which were kept steadily in place by a meniscus-shaped mass of lead weighing ten pounds.

The practice pursued in these cases, it seems to me, is worthy of general adoption, as it usually requires only a very short time to effect a cure, and is unattended with suffering. The success of the treatment, as originally planned and carried out by Dr. Murray, hinges entirely upon the complete arrest of the movement of the blood in the aneurismal sac, and its firm coagulation without the deposition of laminated fibrin, as generally happens in gradual compression. They prove, as the English surgeon justly affirms, that chloroform does not in the slightest degree interfere with the coagulation of the blood, and that, with the aid of this anæsthetic, the treatment is applicable to arteries in the most delicate and

sensitive situations in the body, without any danger from its protracted exhibition. Dr. Murray assumes, as a principle, that in all cases of aneurism of the larger arteries spring-ing from the aorta the best plan is to compress this vessel itself, experience having demonstrated its entire safety.

The results of the treatment of aneurism by instrumental compression are, on the whole, highly flattering, contrasting most favorably with those of the Hunterian deligation. Thus, of 124 cases of compression for popliteal aneurism collected by Mr. Holmes from the records of British hospitals for a period of ten years, 66 were successful, and 58 failed. None died, and there are, indeed, not more than five or six cases of death from the effects of the operation. On the other hand, of 77 cases of aneurism of the popliteal artery, treated according to the Hunterian principle, 11 died, or 1 in 7.

Besides its indisputable safety, compression, whether forced or gradual, has the advan-tage, if it fail, that it does not preclude the propriety of a resort to the ligature.

d. DIGITAL COMPRESSION.

Digital compression for the cure of external aneurism, originally proposed as a distinct measure, in 1846, by Professor Vanzetti, of the University of Padua, was first success-fully employed, a year later, by Professor Knight, of New Haven, in a case of popliteal aneurism, in which he cured his patient in forty hours, the compression having been maintained by a relay of assistants. During the past twenty years, this mode of treat-ment has attracted much attention, both in this country and abroad, and has been fully discussed in statistical papers, particularly by Broca, Verneuil, Petiteau, S. W. Gross, Abbadie, Gaultron de la Bâte, Barlemont, and Fischer.

In a series of communications in the Vierteljahrschrift für Praktische Heilkunde for 1869, Dr. George Fischer has given a statistical report of 188 cases treated by this method. As this paper contains a more full account of the subject than any other which has fallen under my notice, I shall freely avail myself of its contents.

It has been shown that digital compression has been successful where mechanical com-pression was unbearable, or had failed, whether alone or conjoined with other means, interrupted or continued, complete or incomplete ; it has even, in several cases, been applied by the patients themselves, and in these instances either a cure was effected, or the tumor was so modified that subsequent ligation or mechanical compression of the artery always resulted in recovery.

The pain produced by the pressure of the finger is not greater than that caused by the pad of an instrument ; should the point of contact become tender and inflamed, chalk, starch, or flour may be sprinkled upon the surface, or a thin, wet cloth may be interposed between the finger and the skin.   However this may be, suffering, both local and general, may easily be allayed by the free exhibition of anodynes, or by keeping the patient pretty freely under the influence of chloroform.

Of the 188 cases analyzed by Dr. Fischer, 124 were spontaneous and 64 traumatic aneurisms ; 13 were diffuse and 16 were varicose. The tumors were seated in 3 cases upon the iliac ; common femoral, in 7 ; femoral, in 8 ; popliteal, in 90; tibio-peroneal trunk, in 1 ; anterior tibial, posterior tibial, and external plantar, each, in 1 ; subclavian, in 1 ; axillary, in 4 ; brachial, in 32 ; radial, in 7 ; ulnar, in 1 ; superficial palmar arch, in 5 ; carotid, in 4 ; temporal, in 2 ; ophthalmic, in 6 ; supraorbital, in 1 ; and inferior coronary, in 1.

Of the entire number, 121 were cures and 67 failures, including 4 deaths : 104 cures were effected by digital compression alone, and 17 by compression aided by other plans of treatment : 33 cases which had resisted instrumental compression, and which ought not to have been treated by this process, are to be deducted from the 67 instances of failure, so that there remain 138 cases, with 104 cures by digital compression alone, thus affording 75.3 per cent. of success. In these cases, other methods of treatment, chiefly instrumental compression, had previously failed. Digital compression, preceded by instrumental com-pression, was unsuccessful in 19 instances.

One death was due to digital compression employed as the sole method of treatment. The case was that of a man, seventy-one years of age, affected with popliteal aneurism, which became solid at the end of twenty-four hours. Limited gangrene set in, under which he succumbed in two months. In three instances death ensued from the combined employment of the finger and apparatus.

The period required for the cure of aneurism by this method is much shorter than by any other known plan of treatment, except forced instrumental compression. When

employed alone from the very commencement, it frequently does not exceed nine or ten hours. Compared with ordinary instrumental compression, the length of time is most striking. According to Dr. Fischer, a cure, on an average, is effected in three days, whereas the mean duration of treatment by the latter method is fourteen days. The greatest objection to digital compression is the difficulty of procuring a sufficient number of competent assistants.

Dr. Boughter, of the Army, has reported in the Philadelphia Medical Times for October, 1871, the case of a soldier, twenty-four years of age, affected with a double aneurism of the femoral artery, in which the lower tumor, seated in Scarpa's triangle, was cured in five hours and a half by digital compression. No effect was produced upon the upper tumor, which extended slightly under Poupart's ligament, on the one hand, and, on the other, to within an inch and a half of the upper end of the lower sac. The pressure was made over the artery, or, rather, over the mouth of the proximal tumor, against the brim of the pelvis, and was resumed for six hours, at the expiration of four days, with the view of obliterating the latter. Slight diminution in size alone resulted.

In all cases of this operation in which the consolidation of the tumor occurs rapidly, as, for instance, within a few hours after the commencement of the treatment, it is obvious that it must be brought about simply by the coagulation of the blood, without any effort at fibrinous stratification, as always happens when the cure is gradual.

e. DIRECT COMPRESSION OF THE DENUDED ARTERY.

Direct compression of the denuded artery as a means of cure in aneurism has been practised at different periods by different surgeons with a degree of success, in the main, highly flattering and worthy of repetition. Among the earliest operations of this kind are those of Birch, Dubois, Cline, Foster, Deschamps, Percy, Assalini, and Monteggia, near the close of the last and the commencement of the present century. As the original proceedings were more or less rude, it is not surprising that they were occasionally followed by violent inflammation, secondary hemorrhage, and even death. They consisted in exposing the artery at a sound portion of its extent, and surrounding it with a ligature tied over a cylinder of linen, wood, cork, or agaric, retained until the sides of the vessel were supposed to be firmly adherent to each other. Mr. Birch, of London, in 1786, in a case of femoral aneurism, inclosed the artery in two cords, only the lower one of which was tied, the upper one remaining loose, to be tied in the event of accident or secondary hemorrhage. The operation was followed by severe inflammation at the wound, and the aneurism burst on the twelfth day, death occurring soon after. Cline, in a case of a similar kind, employed two broad tapes, one lying behind the other, the outer embracing a piece of cork. Deschamps invented what he termed a serre-artère—a kind of double canula—with which the artery was looped in a manner very similar to that of snaring a nasal polyp with the canula of Levret. A temporary ligature, ligature d'attente of the French surgeons, was placed underneath the artery, above this instrument, to be used in the event of hemorrhage from ulceration of the vessel. Percy employed a pair of forceps with two flat surfaces; while Dubois preferred what is called a presse-artère. Scarpa surrounded the artery with two stout, flat ligatures, the ends of which were tied over a small linen cylinder, six lines in length by three in diameter, the wound being afterwards filled with charpie. Professor Assalini, in the early part of the present century, in a case of popliteal aneurism, successfully employed an instrument very similar to that of Percy, consisting of two short silver blades, united by a rivet, the degree of pressure being regulated by a screw passed through the handle of the instrument. Assalini, as Hodgson informs us, subsequently treated two other cases in a similar manner, the clamp in each being removed at the end of twenty-four hours, without any return of pulsation.

Mr. Crampton, of Dublin, in 1814, in a case of popliteal aneurism, exposed the femoral artery, at the usual site, by an incision three inches in length, and arrested the pulsation with a narrow tape arranged in such a manner as to admit of being tightened or relaxed at pleasure without interfering with the wound. At the end of two hours and a quarter, when the cord was gently slackened but not entirely loosened, all pulsation in the aneurism had ceased. In twenty-four hours the compression was taken off; but, as a measure of precaution, the ligature was retained a day longer. The tumor by the fifth day had decreased one-half in size, and was not only free from pulsation, but almost incompressible. On the eighteenth day the wound was completely cicatrized. Dease, soon after, in a similar case, removed the ligature at the end of twenty-four hours. Travers, of London,

in 1817, tied the brachial artery in a case of traumatic aneurism at the bend of the arm, the ligature being taken away at the expiration of fifty hours. A single noose was employed. The pulsation in the tumor at once ceased, and a complete cure followed without any accident.

The primary object which these surgeons had in view in performing the operations here described was to bring about the consolidation of the contents of the aneurism by retarding and diminishing the flow of blood, precisely in the same manner as in the Hunterian method. In addition to this, some, at the head of whom was Scarpa, aimed at the same time to effect occlusion of the compressed artery by the division of its lining membrane, in the hope of being thus able to favor the effusion of plasma and the adhesion of the contiguous surfaces.

In the modern method the object is to remove the ligature, clamp, or forceps from the artery the moment it is ascertained that there is complete consolidation of the contents of the aneurism. To effect this to the best advantage and in the safest manner, the artery is exposed at the Hunterian site of the tumor to an extent only of a few lines, and inclosed in a single ligature of iron wire, without the addition of the underlying cylinder employed in former times. The best contrivance for the purpose is a flat, metallic button, about one inch and a half in diameter, with two central apertures for the reception of the extremities of the ligature. The wound being closed in the usual manner, the ligature can be tightened or slackened according to circumstances. The pressure may generally be safely removed by the end of the first day.

The value of this operation, as now performed, is still undetermined. I am myself favorably impressed with it. In a case of femoral aneurism, under my charge in 1869, in a man fifty years old, recovery ensued without a single untoward occurrence, the ligature having been removed at the end of the second day. The operation saves time, does not cause much disturbance at the seat of ligation, and is not likely, with proper care, to be followed by secondary hemorrhage, the great danger after such a proceeding. The chief objection to the employment of the wire is the difficulty of detaching it. If a cylinder, as, for example, a piece of gum-elastic catheter or adhesive plaster, be used, it should be placed in direct contact with the skin, the wound having previously been thoroughly closed, otherwise the pressure might provoke severe inflammation, if not ulceration and secondary hemorrhage.

Acupressure of the denuded artery may be substituted for the ligature, wire-loop, or forceps; but it does not appear, from the few trials that have been made of it to possess any special advantages. Mr. Henry Lee refers to a case of small traumatic aneurism of the ham cured by this method. Dr. Cheever, of Boston, has applied it successfully to the femoral artery in popliteal aneurism, but in a second case death resulted from mortification; and Professor Porter, of Dublin, acupressed unsuccessfully the axillary artery in a case of subclavian aneurism.

f. FORCED COMPRESSION WITH THE ELASTIC BANDAGE.

In aneurisms of the extremities forced compression of the arteries leading to and from the seat of the disease has not infrequently succeeded. The treatment is a recent device, first practised, in 1875, by Surgeon Walter Reid, of the English Navy. The compressor employed is Esmarch's bandage. This is applied quite firmly, at first, to the distal side of the tumor, commencing at the extremity of the limb, and reaching as high up as the swelling; it is then carried loosely over the latter so as not to compress it; and, when it has reached its proximal side, it is again applied firmly for a short distance, when the rubber tubing or band is wound round the limb with sufficient tightness to arrest the circulation in the sac, and the bandage is removed. The compression is maintained for a period varying from three-quarters of an hour to three hours and a half, or until there is reason to believe that the contents of the aneurism are completely solidified. As the pain, attendant upon the operation, is often very severe, the patient should, for at least a portion of the time, be kept under the influence of anæsthesia; and, lest the clotted blood should be washed away after the removal of the tubing, the compression should be continued for some hours longer with an ordinary instrument or by means of the finger. The great efficiency of this operation is due mainly, if not entirely, to the arrest of the circulation through the collateral channels as well as through the main artery, thereby securing absolute stagnation of the contents of the sac.

Dr. S. W. Gross has collected seventy cases of aneurism thus managed. The seat

of the disease was the popliteal artery in fifty-three instances, the femoral artery in ten examples, the anterior tibial in two cases, and the posterior tibial, the internal circumflex, the external iliac, the brachial, and the axillary artery, each, in one case. Of the entire number thirty-nine were cured, twenty-seven failed, and four died. In the four cases in which death followed the treatment, the sac and tributary artery were occupied by recent clots. In the successful cases pulsation was perceived in the tumor on the removal of the tubing, but remained permanently absent after the continuance of several hours of digital or instrumental compression. The chief danger after this operation is from gangrene of the limb from the size or extension of the clot. The four deaths were due to gangrene in two, to collapse and impending gangrene in one, and to collapse with rupture of an aneurism just above the pad of the tourniquet in one.

g. FORCED FLEXION.

Fleury, a French military surgeon, it would seem, originally suggested the idea that forced flexion might be beneficially employed in the treatment of aneurism of the extremities; a suggestion which was first successfully practised in 1852, by Thierry, of Paris, in a case of traumatic aneurism at the bend of the arm. In 1857, Maunoir, of Geneva, availed himself of this treatment for the cure of a large aneurism of the ham; and shortly afterwards the treatment was successfully employed by Mr. Ernest Hart, of London, through whose writings it became known in Great Britain and in this country. It is chiefly applicable to aneurism of the ham and of the bend of the arm, although it has also been successfully employed, by Dr. Gurdon Buck and Dr. Eldridge, in aneurism of the groin, and it might, possibly, be practised in aneurism of the axilla. The principle of the treatment consists in moderating and retarding the flow of blood in the tumor, as for instance, in the lower extremity, by bending the leg forcibly upon the thigh, so as to approximate the heel to the buttock, and confining it there by means of a strap, the limb being previously enveloped in a bandage. The patient need not be rigidly confined to bed, but may occasionally sit up, and even exercise on crutches. Pain and stiffness of the limb may be diminished with inunction of oil and chloroform. Care is taken to move the knee occasionally, lest ankylosis should occur. The cure is commonly very tedious, from three to six weeks being required for the complete arrest of the pulsation, and in a number of the cases in which this treatment has been pursued it has signally failed; in several, the patient was unwilling to bear the restraint which it imposed, and in one at least it was followed by rupture of the sac into the joint, necessitating the ligation of the femoral artery. In a case of popliteal aneurism, the volume of a small fist, in a man nearly forty years of age, a patient at the College Clinic, I effected a cure by forced flexion in less than twenty-four hours.

It is obvious that this mode of treatment, which commends itself chiefly by its great simplicity, is more likely to succeed in small and recent aneurisms than in large and old, in which it must of necessity be occasionally attended with failure. Indeed, it can hardly be considered as applicable to the latter class of cases, as it might induce rupture of the sac, or even be productive of gangrene of the leg.

Of 106 cases of popliteal aneurism, treated by forced flexion, the statistics of Dr. Fischer and Liégeois, afford 45 cures and 54 failures, the successful issues in 29 of the former cases having been obtained with the aid of other methods. 7 cases died from rupture of the sac.

h. GALVANO-PUNCTURE.

It would seem that this operation for the radical cure of aneurism was first suggested, in 1832, by Mr. Benjamin Phillips; so far, however, as my information extends, it was not practised by him upon the human subject, and the idea had been almost lost, when, about thirty years ago, it was revived, principally through the agency of Pétrequin, of Lyons. The operation is founded upon a knowledge of the fact that the galvanic current has the effect, if properly directed, of coagulating the blood as it circulates through the different parts of the body. It is executed by means of two long, slender steel needles, introduced into the aneurismal sac at right angles, and in such a manner as to touch each other, their heads being then connected with a battery of large electro-motor force. The action of the battery is maintained uninterruptedly for a period varying from ten to twenty-five minutes, according to the tolerance of the part, and is usually required to be several times repeated. When the tumor is large, the number of needles is increased, and the direction of the current frequently changed, so as to afford a better chance for

the formation of clots. As the operation is generally very painful, it is proper that the patient should be placed under the influence of anæsthesia during its performance. Moreover, as there is danger of seriously charring the integument, and thus endangering the sac by mortification, the needles should be carefully coated, in a part of their extent, with gum-lac. The success of the procedure is enhanced by compression of the artery above and below the tumor, thereby preventing the clots from being washed away, before an opportunity has been afforded them of becoming consolidated and united with each other and with the walls of the aneurism. The after-treatment consists in the application of ice to the part, in perfect quietude, and in the administration of a full anodyne, to tranquillize the action of the heart and arteries.

Experience has not fully determined the value of this mode of treatment. That it is liable to occasional failure is sufficiently evident from the unsuccessful cases that have from time to time been published in England and on the continent of Europe. On the other hand, a considerable number of cases have been reported in which its employment was followed by a perfect cure. Of 50 cases, collected by Ciniselli, in 1856, in which the operation had been practised, 23 were successful, 20 failed, and 7 died. Examples of cure, by this method, of aneurism of the aorta, the brachial, subclavian, popliteal, and external iliac arteries, have been reported by different observers since that period, and, doubtless, others have occurred of which I have no knowledge.

Galvano-puncture is not only painful, but far from being devoid of danger. In some of the reported cases it produced severe inflammation and even suppuration of the sac, followed by great swelling of the limb, together with excessive constitutional disturbance, threatening the destruction both of the part and system. The operation is, therefore, a hazardous one, and on this account should never be attempted without due consideration of its consequences, especially when the aneurism is large, and situated at, or near to, the trunk. Coupling this circumstance with the want of success of the operation, and the severe pain attending its execution, not to say anything of the danger of producing sloughing in the skin and sac by the action of the galvanic fluid as it is being transmitted from the battery to the tumor, it is questionable whether it is worthy of repetition, notwithstanding the high estimate placed upon it by Pétrequin, Burci, and some other surgeons. The force of this conclusion derives additional support from the facts collected by Boinet, that in seven of the successful cases, above referred to, compression and ice were employed simultaneously, thus creating a just doubt whether these agents had not as much to do with the cure as galvano-puncture, if, indeed, not more.

i. INJECTIONS.

Attempts have been made in modern times to effect the radical cure of aneurism by the injection of certain fluids with a view of favoring the concretion of the blood, the consolidation of the sac, and the obliteration of the affected artery at the seat of the disease. The practice was originally suggested, early in the present century, by Professor Monteggia, of Milan, who proposed the use of solutions of acetate of lead, tannic acid, and other astringents, as, in his opinion, well adapted to the purpose, although he never, it would seem, performed the operation. His idea was that, by throwing these substances into the sac, so as to bring them fully into contact with the blood within, it might be possible to provoke the rapid formation of coagula, and thus effectually arrest the circulation. He supposed, moreover, that the remedy might occasionally be advantageously combined with Brasdor's operation and with compression of the artery upon the cardiac side of the tumor, applied by means of a tourniquet or some other suitable instrument, very much as it is

Fig. 333.
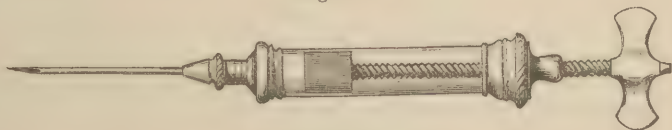
Pravaz's Syringe.

performed at the present day. The suggestion of the Italian surgeon, however, received little, if any, attention until within a comparatively recent period, when it became the subject of numerous experiments upon the inferior animals, as the sheep, dog, and horse, principally by the French practitioners, who, after having tried various articles have at

length been induced to give a decided preference to a concentrated solution of perchloride of iron in water. The fluid is introduced into the sac by means of a small glass syringe, invented by Dr. Pravaz, of Lyons, and represented in fig. 333. The piston is moved slowly by means of a screw, not more than five or six drops of fluid being thrown into the sac, that quantity having been found to be amply sufficient for the purpose. As it takes at least half a minute before the blood can be made to coagulate, during which the heart performs not less than thirty-five pulsations, it is necessary to keep the contents of the tumor perfectly quiet, while the injection is progressing, by compression of the artery immediately above and below the aneurism.

The operation is generally productive of severe pain, and as it is liable to be followed by considerable inflammation, it often becomes necessary to make use of antiphlogistic measures, both locally and constitutionally. Its repetition must be governed by circumstances; if everything passes off well, and the sac is promptly solidified, no further interference will, of course, be demanded; but, if the reverse be the case, a similar quantity of the solution is thrown in at the end of the third or fourth day, in the same cautious manner as before. The slightest inflammation of the tumor contraindicates the repetition of the injection.

Since 1853, when Pravaz first published the results of his experiments on animals, a number of cases have been reported in which injections of perchloride of iron have been employed in aneurism of different parts of the body, as well as in aneurism of different kinds, as spontaneous, traumatic, and varicose. The arteries upon which the disease occurred were the supraorbital, carotid, brachial, ulnar, femoral, popliteal, and tibial. More recently the treatment by injection has been extended to aneurism of the innominate artery by Barrier and Eliot, of the subclavian by Pétrequin, and of the aorta by Syme and Hutchinson, but in no instance with success.

Although a few cures have been effected by this treatment, such is the great risk of inflammation, suppuration, and even gangrene, both of the sac and of the surrounding structures, that it is extremely questionable whether any prudent surgeon should repeat it. Of eleven cases, reported by Malgaigne in 1854, it is announced that four had proved fatal, that every one had had bad symptoms, and that only two had been successful. This statement alone, if true, as no doubt it is, is sufficient to condemn the operation as unsafe, and to render its adoption improper in the face of the more unexceptionable methods of ligation and compression. The great desideratum is to discover an article, which, while it shall promptly coagulate the blood, will not cause any severe irritation in the sac and parts around it. It has been supposed that the acetate of the peroxide of iron might have this effect, but, although at least one successful cure by its use has been reported, it has not been tried sufficiently often to enable us to pass any definite judgment upon its true merits. I should myself have more confidence in the efficacy and safety of subsulphate of iron than in any other preparation of this metal. It is perfectly destitute of caustic properties, and is the most prompt and efficient coagulator of the blood at present known.

At a meeting of the Philadelphia Academy of Surgery, in 1882, Dr. W. W. Keen reported the particulars of a case of aneurism of the palm of the hand, in which an injection of ten drops of diluted Monsel's solution caused rapid mortification necessitating amputation of the lower part of the forearm.

Subcutaneous Injection of Ergotine.—The subcutaneous injection of ergotine, in view of its influence in provoking contractions of organic muscular fibres, has been employed in a few instances of aneurism, and the results have been so far favorable as to warrant its further trial. Professor Von Langenbeck, with whom the practice originated, has reported the case of a man, forty-two years of age, who had been affected with an aneurism of the radial artery, of the size of a hazelnut, for twenty years. The injection of about three grains of ergotine between the skin and the tumor, was followed, in twenty-four hours, by its complete subsidence. It reappeared momentarily, in consequence of a slight effort made by the patient, but had entirely vanished at the end of eight days. In a second case, one of subclavian aneurism, of the size of a fist, in a man, aged forty-five years, about thirty grains were injected in the course of six weeks, at intervals of three days, and in quantities varying from half a grain to three grains. The tumor was somewhat shrunken, the pulsations were sensibly weakened, and the pain and paralysis of the arm and hand were diminished to a remarkable extent.

j. ACUPUNCTURE, AND INSERTION OF FOREIGN MATERIALS.

The idea of curing aneurism by acupuncture seems to have first suggested itself to the fertile mind of Velpeau, who ascertained by experiments upon dogs that, if needles be thrust into an artery, the blood manifests a tendency to form clots around them, which, in a short time become so firmly adherent as to cause more or less obstruction in the circulation. He thought that this plan might be applied to the treatment of aneurism, but this was not done until 1831, when it was successfully employed in a case of carotid aneurism by Mr. Benjamin Phillips, of London. In 1879, Mr. Christopher Heath inserted three pairs of fine sewing needles into a traumatic subclavian aneurism, for which he had amputated at the shoulder-joint two months previously. The needles were withdrawn on the fifth day, and the tumor became solid. After death from bronchitis, the aneurism was found to be nearly filled with dense fibrin. In a case of ilio-femoral aneurism recorded by Dr. Macewen, acupuncture conjoined with proximate compression proved successful. In view of the limited experience with the procedure, it is difficult to form an estimate of its value; and this is particularly true of the cases of Heath and Macewen, in which the other measures employed probably contributed greatly to the success.

Under this head may be briefly mentioned *caloric puncture*, a process originally employed in 1825, by Sir Everard Home, under the supposition that the application of heat would favor the coagulation of the blood. His case was one of aneurism of the external iliac artery, for which he had twenty-eight days previously tied the superior portion of the femoral. He inserted a solitary needle into the tumor, and then heated its head with the flame of a spirit lamp. The pulsation became somewhat weaker under the application, but the tumor was not lessened by it. A second application was made six days after, with a large needle, retained for thirty-five minutes. The pulsation greatly diminished in force, and the contents of the tumor seemed to be solidified. Three days later, however, the pulsation recurred with its accustomed freedom, a circumstance which suggested a third trial. At the end of twenty minutes all pulsation had ceased and did not reappear afterwards.

Mr. Moore, of London, in 1864, in a case of large aneurism of the arch of the aorta, projecting across the ribs, and almost ready to burst, attempted to induce coagulation by means of the introduction of a large quantity of fine iron wire, altogether twenty-six yards in length. It was inserted through a delicate canula, and deposited in every direction in the sac. Rapid coagulation was the consequence. Violent inflammation, however, soon ensued, pulsation recurred in the tumor, and the man died exhausted on the fifth day after the operation.

The procedure suggested by Mr. Moore has been imitated by Domville, Murray, Levis, Bryant, Stimson, Maury, Montenovesi, and Bacelli, the materials used having been iron wire, catgut, horsehair, or watch springs. It has proved to be utterly useless, and is tedious and difficult of execution.

k. MANIPULATION.

The treatment of aneurism by manipulation was first formally proposed, in 1852, by Sir William Fergusson. It consists in the forcible squeezing of the tumor, with the intention of breaking up its fibrinous contents, in order that some of the fragments thus detached may be carried by the circulation into the distal extremity of the artery, thereby closing its orifice, and so effecting a radical cure. The first case in which the treatment was tried was one of aneurism of the right subclavian artery, seated partly within and partly on the outside of the scalene muscles, the tumor being about the size of a hen's egg. The sac being emptied of fluid blood, its sides were forcibly rubbed against each other, with the immediate effect of an arrest of pulsation in all the vessels in the limb below. The pulsation, however, returned in about seven hours, and the manipulation was accordingly repeated the next day with a similar result, but it was not until the end of a week that any permanent impression appears to have been made upon the circulation. The tumor now gradually diminished in size, and everything gave promise of an ultimate cure, when suddenly, seven months afterwards, the patient was seized with violent fever attended with excruciating pain in the part, and died after a few days' illness. Although the axillary artery was found, on dissection, to have been blocked up, the tumor, instead of being obliterated, not only remained hollow, but had extended downwards over the axillary plexus of nerves, the pressure upon which had probably caused the excessive pain which immediately preceded dissolution. In another instance, also treated by Fergusson, the

result was more fortunate, but the cure was not finally effected until towards the end of the second year. Dr. Little, in 1856, obliterated by this means an aneurism of the right subclavian artery.

In a case of popliteal aneurism, reported in 1859 by Mr. Teale, of Leeds, this plan of treatment was successfully conjoined with digital compression. After the latter had been carried on for some time, with, apparently, very little effect, a portion of clot was detached, leading at once to the consolidation of the tumor. The late Professor Blackman, in a case of large femoral aneurism, was equally fortunate. In 1872, Herbert Page, of England, treated a case of popliteal aneurism successfully by this means.

Although no opportunity has presented itself to me of trying this plan of treatment, it is, I think, extremely questionable whether it ought to be repeated. The great objections to it are, first, the uncertainty of the operation, even when the distal end of the artery has been blocked up; secondly, the tardiness of its progress; and, thirdly, the danger that some of the detached clots may find their way into the brain, as in aneurism of the neck, thus causing fatal apoplexy, as has already happened in several cases in which the method has been tried. If employed at all, therefore, it should be restricted to aneurism of the subclavian, axillary, femoral, and popliteal arteries, in the early stage of the disease, before the tumor has acquired any considerable bulk; and the treatment will be so much the more likely to be successful if the circulation in the tumor be kept in check for some hours by pressure upon the cardiac side of the artery.

l. OPERATION OF OPENING THE SAC.

For the reintroduction of this operation, known as the operation of Antyllus, one of the most delicate, difficult, and hazardous that can be undertaken, the profession, as stated in a previous page, is indebted to the late Professor Syme, who did so much to advance practical surgery. It consists, as the name implies, in laying open the sac, turning out its contents, and ligating the diseased vessel above and below the tumor. The procedure is mainly applicable to aneurism of the arteries of the extremities, particularly the femoral and popliteal, to the former of which it has been successfully applied by Mr. Gay, Mr. Birkett, and Mr. Cooper Forster, and to the latter by Mr. Henry Smith; but it has also been performed for aneurism of the common carotid, axillary, and external iliac, as in the remarkable case of Mr. Syme, in which, for an enormous tumor of the last vessel, he tied the common, internal, and external iliac arteries, after having turned out six pounds of coagulated blood and fibrinous concretions. The patient recovered from the operation, but died in three months from another disease. In 1875, Dr. Frothingham, of Ann Arbor, in a case of traumatic aneurism of the common carotid artery, turned out the clots, and tied the artery at both ends, the operation being followed by a perfect cure.

One great danger of this operation is from hemorrhage, which may be so rapid, excessive, and overwhelming as to render it impossible to control it before it proves fatal. Another source of danger is from the resulting inflammation, which must necessarily be very great when the tumor is large and of long standing, and liable to be followed by profuse suppuration, if not ulceration and gangrene. As yet, the number of cases of this operation is too limited to justify us in pronouncing a final verdict in regard to its value. Indeed, even the particular class of cases to which it is applicable has not been determined.

The first point in such an operation is to guard against hemorrhage by means of the tourniquet or the elastic bandage, or, if this be impracticable, by digital compression. In Mr. Syme's celebrated case, the circulation in the aorta was controlled by an instrument passed around the abdomen, and the patient, consequently, lost hardly any blood. In laying open the sac, the proper plan undoubtedly is to make, at first, as suggested by the Scotch surgeon, a very small incision, an incision barely sufficient to admit the fingers, and then to enlarge it gradually until the whole hand can be insinuated, which thus answers as a plug to the wound while the fingers are pressed firmly against the orifices of the diseased artery so as to restrain the escape of their contents. As soon as the flow of blood is fully arrested, the aneurism is freed of its clots and concretions, and the artery tied above and below, or at its cardiac and distal extremities, the latter precaution being essential to the prevention of hemorrhage by the recurrent circulation. The application of the ligature will be greatly facilitated if, as was originally practised by Antyllus, and lately by Mr. Birkett, of Guy's Hospital, a probe, bougie, or director be introduced into the vessel, to serve as a guide to the knife, which cannot be used with too much caution,

inasmuch as the artery is often overlapped, to a considerable extent, by the aneurism, and cannot be properly exposed without a most delicate and tedious dissection. Any undue oozing from the inner surface of the sac may readily be arrested by the use of Monsel's salt.

The after-treatment must be conducted with special reference to the avoidance of secondary hemorrhage, high inflammation, erysipelas, and pyemia. The suppuration must necessarily be often very profuse, and it is, therefore, impossible to be too zealous in the use of detergent and deodorizing lotions, fresh air, and a properly regulated diet.

m. VALSALVA'S TREATMENT OF INTERNAL ANEURISM.

Internal aneurisms, inaccessible to the ligature and compression, occasionally recover under a regular and systematic course of treatment designed to promote the coagulation of the blood in the interior of the tumor, by increasing the plastic properties of this fluid, and quieting the action of the heart and arteries. This treatment, which was originally suggested by Valsalva, and which still bears his name, consists in the strict observance of the recumbent posture, perfect mental quietude, the occasional abstraction of blood from the arm, and the use, simply, of a sufficiency of food and drink to prevent starvation. When, writes Morgagni, Valsalva had taken away as much blood as was deemed necessary, he diminished the diet " more and more every day, until only half a pound of pudding was taken in the morning, and in the evening half that quantity, and nothing else except water, the weight of which was also regulated, and which he medicated with what is called quince-jelly, or the lapis osteocolla, ground down into a very fine powder. After the patient had been sufficiently reduced by this method, so that he could scarcely raise his head from the bed, to which, by Valsalva's direction, he was confined, the quantity of aliment was day by day increased, until the strength that was necessary to enable him to get up had returned."

Whether Valsalva effected any cures by this method of treatment is not known; if he did, they must have been very few, as the plan is, with one or two exceptions, founded upon entirely erroneous principles, frequent venesection, and a very reduced diet, almost carried to starvation, being anything but conducive to the fibrinization of the blood in the aneurism, by which alone the alteration of the sac can be essayed. Indeed, experience has shown that the only true course to be pursued is the physiological one, in which the abstraction of blood is scrupulously abstained from, at the same time that a sufficient amount of food is allowed to prevent that irritability of the system which is always sure to arise when the body is for any length of time imperfectly nourished. The quantity of solid food should not be less, on an average, in the twenty-four hours, than from nine to twelve ounces, consisting of equal parts of hashed meat and bread, potato, or rice, at dinner, with a suitable quantity of stale bread, toast, or cracker at breakfast and supper; tea, coffee, and all other drinks, excepting water, lemonade, and milk, as well as all kinds of condiments, being strictly avoided. The patient should be kept perfectly at rest, in the recumbent posture, with the mind in as tranquil a state as possible, while the system should be steadily maintained under the use of tincture of aconite, or of veratrum viride, conjoined with acetate of lead and opium; or, what would be better, as more likely to promote fibrinization of the blood, ergot and subsulphate of iron. The pulse should be brought down, if practicable, to forty-five or fifty beats in the minute, and the chances of success would be all the greater if a prolonged state of somnolency could be maintained, the patient sleeping the greater part of the twenty-four hours. Protracted constipation of the bowels should be aimed at; if purgatives become indispensable, they must be of the mildest character, as all irritating and griping articles are sure to do harm by exciting the action of the heart and arteries.

The length of time during which this treatment should be continued must vary according to the circumstances of each individual case, and no attempt should, therefore, be made to reduce it to any general principles. It certainly might, with judicious management, be kept up, without detriment, for a number of consecutive weeks, if, indeed, not several months. As the patient emerges from it, he should return, very gradually and cautiously, to his accustomed diet, except that, for a long time afterwards, it should be free from all stimulants; nor should he, for a similar reason, take any, except the most gentle, exercise. In short, everything should be done to second nature in her efforts to effect the cure thus auspiciously begun, and which, other things being equal, will always be so much the more likely to take place if the aneurism is small and of recent standing.

My opportunities for treating abdominal and intrathoracic aneurisms according to the plan here sketched have not been sufficiently extended to enable me to form anything like a correct estimate of its value. In the cases in which I have employed it, although the patients seemed to be materially benefited, so far as pain was concerned, and the pulse was brought down below fifty, the progress of the disease was apparently not at all retarded. It is proper, however, to add that all the cases were far advanced when they fell into my hands. Professor Tufnell, of Dublin, in 1874, reported a number of instances treated upon this principle, in which permanent cures were happily effected. In a case reported by Mr. Head, in 1877, an aneurism of the innominate artery, apparently in a very unfavorable condition, was successfully relieved by this method. Pelletan, Surgeon to the Hotel-Dieu, of Paris, in the early part of the present century, obtained remarkable results from the Valsalvian method: he conjoined with it the application of ice, or of cold and astringent lotions, and a number of his cases were either partially or completely cured by it. Roux also had a successful case of aneurism of the thoracic aorta.

To sum up the modern medical treatment of internal aneurisms, the essential points consist of perfect tranquillity of mind and body, absolute confinement in the recumbent posture, a restricted diet, consisting principally of solids, a retarded circulation, and a healthy state of the blood.

When the cause of the disease is a syphilitic taint of the system, the most reliable internal remedy undoubtedly is iodide of potassium, either alone or in union with mercury, in doses, at first, of eight or ten grains thrice a day, gradually increased to fifteen or even twenty grains, according to the tolerance of the stomach. Excellent cures are occasionally effected by this remedy in cases even apparently more or less desperate.

n. GENERAL MEDICAL AND SURGICAL TREATMENT.

Persons affected with aneurism often experience, as stated elsewhere, great pain and other suffering, both from the inflamed condition of the tumor and from the pressure which it exerts upon the surrounding parts. In aneurism of the thoracic portion of the aorta and of the arteries at the root of the neck, the pain and dyspnœa are sometimes excessive, demanding prompt and vigorous measures for their relief. If the patient is plethoric, and the pulsation in the tumor uncommonly active, the loss of six, eight, or even twelve ounces of blood will be useful, but care must be taken not to carry the venesection too far, otherwise injurious reaction may take place, and thus aggravate the suffering. When the tumor is accessible, or situated externally, whether partly or entirely, the blood is often most advantageously abstracted directly from the part by means of leeches, which, even when employed only in small numbers, generally afford immense relief, both as it respects the pain and the difficulty of breathing. Topical depletion is always extremely serviceable in inflamed aneurism, and it is here also that fomentations and refrigerating lotions, simple or medicated, come into play, frequently exerting their happiest influence. The choice of these remedies must be governed in these, as in other cases, by the tolerance of the part and system. Attention to position and rest must be enjoined, and strictly carried out. The bowels are not neglected, but great care is taken to avoid active purgation, experience having shown that this always produces undue excitement of the vascular and nervous systems. Anodynes are always well borne in these cases, and are often indispensably necessary to relieve pain and promote sleep; they should be administered in full doses, either alone or in union with diaphoretics and expectorants, according to the condition of the skin and of the respiratory organs. Any complications that may arise during the progress of the disease, whether self-existent or dependent upon the irritation produced by the pressure of the tumor, must be treated upon broad general principles.

When an aneurism becomes diffused, by parting with its fluid contents, in consequence of the partial destruction of its sac, whether by ulceration, gangrene, or rupture, the case at once assumes an additional importance, inasmuch as the occurrence greatly increases the patient's danger. In internal aneurism little is to be done in the way of treatment, under such circumstances, beyond attention to the circulation, the moderation of the force and frequency of which may, perhaps, assist in prolonging life, and, occasionally, there is reason to believe, even in effecting a radical cure by promoting the formation of coagula. When the disease is seated in an extremity, as the thigh or leg, and the tumor is of comparatively small size, without any tendency to gangrene in the distal portion of the limb, the proper plan unquestionably is, either to tie the main artery, or to arrest the circulation in the tumor by rapid and forcible compression while the patient is under the influence of anæsthesia. In this way, further extravasation will be prevented, and the

case will be likely to progress favorably. If, on the contrary, the tumor is of immense size, the limb hugely swollen, and the pulsation completely arrested; or if, in addition to all this mischief, there is marked gangrene, the only safety is immediate amputation at a suitable distance above the aneurism.

FALSE ANEURISM.

A false aneurism is a pulsating tumor formed external to the affected artery, and, consequently, without any aid whatever from its tunics. A number of affections, of a very opposite character, have been described under this appellation, and much confusion has been the result. To remedy this evil, I shall limit myself, in the account which I am about to give of the disease, to two varieties of false aneurism, the arterial and arteriovenous, the tumor in each being strictly circumscribed, and connected, in the former, with an artery, and, in the latter, both with an artery and a vein. What is called a diffused aneurism is, in fact, as stated elsewhere, no aneurism at all, but simply an accumulation of blood in the subcutaneous and intermuscular connective tissue, which, although it may be somewhat condensed around it, does not, in reality, in the true meaning of the word, constitute a proper aneurismal sac.

The most common cause of the spurious arterial aneurism is external injury, as a stab or puncture, such, for example, as was formerly so often inflicted in venesection at the bend of the arm, permitting the blood to escape in small quantity into the surrounding connective tissue, which is soon condensed into a firm, circumscribed, pulsating cyst, often not exceeding the volume of a pullet's egg, and of a rounded or ovoidal figure. Similar effects occasionally follow the laceration of an artery, as that of the ham, from the sudden and forcible extension of the leg, from the intrusion of the sharp end of a broken bone, or from ulcerative action.

Sometimes the aneurismal formation is secondary; that is, consequent upon the partial cicatrization of the wound, the interposed or overlying plasma being unable to withstand the impulse of the blood, and so yielding before it. However induced, all the tunics of the artery are at once perforated, and the blood is sent abroad into the circumjacent connective tissue, in the manner and with the effect just stated.

The sac in this variety of aneurism, formed originally out of the neighboring connective tissue, is speedily strengthened by the effusion of plastic matter, so that, in time, it often acquires considerable thickness, with an extraordinary degree of density. A number of cases have been under my observation in which the cyst, even at an early stage of the disease, was of a very firm, compact, fibroid consistence, and of a white, glistening appearance, its substance being convertible, by dissection, into several distinct strata. The tumor, particularly in cases of long standing, generally contains well-organized concretions, arranged in the same concentric manner as in the true sacculated aneurism, and presenting a similar hue and consistence. The course, symptoms, and termination of this disease do not require any special notice, as they do not differ, in any respect, from the ordinary form of the affection.

The treatment may be conducted by compression, or, this failing, by ligature. The compression is applied, as in true aneurism, upon the cardiac aspect of the tumor, four, six, or eight inches from it, with the instruments already described, retardation of the circulation and gradual obliteration of the sac being steadily kept in view. If an operation becomes necessary, a free incision is carried across the tumor, and a ligature applied immediately above and below, as in an ordinary wounded artery. The tumor may then be dissected out, or, as some prefer, although I think improperly, it may be left to the influence of the absorbents. As a preliminary step, a tourniquet is cast around the limb, to control the circulation in the affected vessel. Although one ligature is occasionally sufficient to effect a cure in this disease, it is always best to ligate the vessel both above and below the swelling, lest trouble should arise on account of the recurrent circulation, and thus lead to the necessity of doing at a subsequent period what ought to have been done in the first instance. The memorable case of Anel affords an excellent illustration of the fact that an aneurism of this kind, especially when seated at the bend of the arm, may occasionally be cured by one ligature applied just above the tumor.

1. The *arterio-venous* aneurism, originally described under the name of varicose aneurism, is a tumor situated, as the term implies, between a contiguous artery and vein, so as to admit of a ready interchange of the two kinds of blood. The most common site of it is the bend of the arm, as seen in figs. 334 and 335, where it is generally caused by a puncture in bleeding, in which the overlying vein, usually the median basilic, is

completely transfixed along with the superficial wall of the brachial artery.   A similar accident may, of course, happen in any other part of the body, from a stab or wound of a contiguous artery and vein, as between the femoral, or the aorta and vena cava; and, what is remarkable, the disease occasionally does not show itself until long after the infliction

Fig. 334.
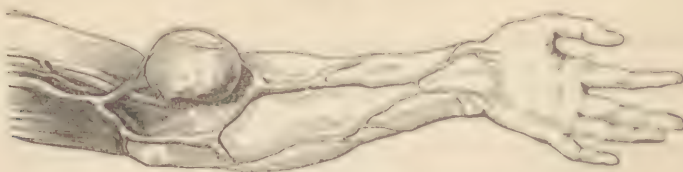
Varicose Aneurism ; External Appearance.

of the injury.   Thus, Roux relates a case in which an arterio-venous aneurism formed at the bend of the arm four years after venesection; and Rokitansky observed a similar tumor in the axillary artery and vein thirty years after they had been struck by a shot. Sometimes, again, the aneurism forms in consequence of ulceration, beginning in one vessel and gradually extending to the other, and so eventually establishing a communication between them through the intervention of a sac.   Dissection has proved that such a connection may take place in deeply-seated as well as in superficial veins.   In a case described by Schottin the aneurism existed between the radial artery and the cephalic vein; and in one seen by Charnal it had formed between a deep vein and the brachial artery.

Fig. 335.

Varicose Aneurism ; Internal View.   a. The Artery.
b. The Vein.   c. The Intermediate Cyst.

A remarkable case of arterio-venous tumor, altogether unique in character, in which the cyst was formed by the expansion of the component structures of a nerve, has been reported by Mr. C. H. Moore, of London.

In whatever manner the aneurism is formed, the cyst is usually of small size, seldom exceeding, and not often equalling, that of a pullet's egg.   It is composed partly of condensed connective tissue and partly of plastic matter, the latter always greatly predominating, as is shown by its extraordinary thickness as well as density, which closely resembles that of the fibrous tissue.   The aneurism, although seldom very painful, always interferes more or less with the functions of the affected limb.   As the opening of communication is always very small, the blood rushes into it with a peculiar noise, not unlike that produced by the buzzing of a fly in a paper box, or the purring of a cat. Sometimes the sound is of a whirring character, similar to the prolonged articulation of the letter R.   It is perceived both by the ear and finger, and is so extraordinary that it may be regarded as pathognomonic.   The sac rarely contains any well-formed fibrinous concretions, and, hence, it is generally found to be perfectly smooth, white, and glistening, like the interior of an artery.   Manifesting little disposition to increase, it may remain stationary for years, and seldom, if ever, undergoes spontaneous cure, or terminates in rupture, ulceration, or grangrene.

When the tumor is very small, not exceeding the volume of a filbert or a pigeon's egg, and does not occasion any suffering, interference is neither desirable nor proper; it is merely an inconvenience, and had better be let alone.   The reverse, however, is usually the case, and then the same treatment will be required as in spurious aneurism connected with an artery only; that is, the vessel is tied immediately above and below the tumor, which is either left to undergo absorption, or, what is often preferable, it is carefully dissected out; an operation which, if performed with the aid of the elastic bandage, is generally bloodless.

Digital compression of the artery above the sac and of the opening leading from the sac to the vein should be employed before resorting to harsher measures.   Of fourteen examples, in at least six of which the above method was employed, eleven were cured.   In a case of varicose aneurism of the brachial artery Vanzetti succeeded in effecting a cure in six hours.

When the disease occurs in connection with the aorta and vena cava, operative interference will, of course, be out of the question; nor can anything be hoped for from medical treatment. The case, in fact, is irremediable, and will be sure eventually to cause death, either by the gradual giving way of the sac, or by exciting violent irritation, pain, and constitutional disorder.

2. *Aneurismal varix*, fig. 336, consists in a direct communication between a contiguous vein and artery, without the intervention of a sac; it differs, therefore, essentially from a varicose aneurism, in which, as has just been seen, there is always a distinct cyst, formed

Fig. 336.
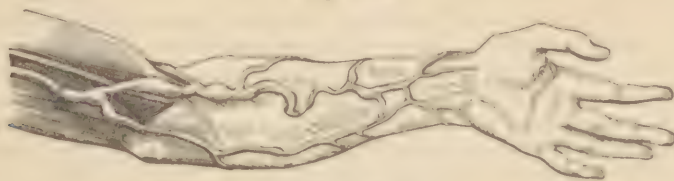
Aneurismal Varix.

out of the surrounding tissues, along with more or less plasma. The affection is altogether so unlike aneurism, whether true or spurious, that it is surprising it should ever have been included in the same category.

The cause of aneurismal varix—a disease first described by Dr. William Hunter, in 1756—is usually some external injury, such as a puncture, transfixing a vein and piercing the contiguous wall of an underlying artery. Hence the lesion is most common at the bend of the arm, between the median basilic vein and brachial artery, in consequence of venesection. It may, however, occur between other veins and arteries lying in juxtaposition with each other, either through accident, or from the effects of ulceration commencing in the coats of one vessel and gradually perforating those of the other. In fact, it has been noticed in all the larger vessels, as the carotid and jugular, the subclavian, and axillary, the aorta and vena cava, the iliac, femoral, popliteal, and tibial. Several cases have fallen under my observation in which the disease followed upon amputation of the thigh. The orifice of communication is usually small, and of a circular shape, with well-defined margins, although there is, in this respect, no particular uniformity. The adhesion between the two vessels is generally very firm, as well as of considerable extent, and it is well that it should be so, otherwise there would be constant danger of the connection giving way. Owing to the incessant interchange and commingling of the two kinds of blood, the vessels gradually undergo important changes, the most interesting of which are that the vein assumes the properties of an artery, and the artery those of a vein. The vein, from the impetuous manner in which the arterial blood is sent into it at each stroke of the heart, becomes greatly enlarged both above and below the abnormal opening, at the same time that it acquires an extraordinary degree of density, and pulsates with unusual force. In the arm, in which I have met with a number of instances of this disease, I have found the dilatation of the vein to extend, on the one hand, nearly as high up as the axilla, and on the other, as low down as the middle of the forearm. The artery, which now receives black blood, but not in any large quantity, is eventually transformed into a soft, thin, flexuous tube, which, possessing the properties of a vein rather than those of an artery, pulsates but feebly under the finger.

The formation of this disease is generally attended with some degree of pain and swelling, along with interstitial effusions, causing the integument to pit slightly on pressure. The parts below the seat of the lesion are imperfectly nourished, and hence they usually feel somewhat cold and numb until the circulation is fully reëstablished through the agency of the collateral branches. As the blood passes from one vessel into the other, it produces a peculiar jarring sensation and a singular whirring noise, not unlike the purring of a cat, which often extends to a great distance along the dilated vein, now performing vicariously the functions of an artery, and which may be regarded as the pathognomonic signs of the disease. Occasionally a distinct tumor of considerable bulk is formed, consisting mainly of enlarged and tortuous veins.

In most of the cases of this lesion that have fallen under my observation, the inconvenience has been so trifling that I have not considered it proper to resort to operative interference. In one instance the patient had an aneurismal varix on the right arm from venesection performed upwards of fifteen years previously, and, although he was a black-

smith and a hard-working man, it did not in the least interfere with his occupation. Cases of aneurismal varix in different parts of the body, in which the disease remained station-ary for fourteen, twenty, thirty, and even thirty-five years, are mentioned by Hunter, Pott, Bell, Guattani, Scarpa, Breschet, Dupuytren, and other writers.

Several instances have been recorded in which a spontaneous cure is said to have taken place, but such an event must necessarily be very uncommon. The inconvenience caused by the pain and throbbing, which are often very distressing, may generally be greatly miti-gated by the steady and persistent use of an elastic bandage or stocking, as in the treat-ment of varicose veins of the extremities. When the parts are hot and inflamed saturnine lotions will be of benefit, especially if combined with rest and elevation of the parts. Cases in which a cure was effected by steady systematic compression have been recorded by Guattani, Monteggia, Oldknow, Samuel Cooper, and others.

The surgical treatment of this variety of aneurism has, within the last few years, ac-quired new interest from the fact that in nearly every instance in which the so-called Hunterian operation has been employed, the result has been fatal, the immediate cause of death being gangrene, or secondary hemorrhage, or a union of both. The cases of Physick, Atkinson, Mott, Charles Bell, Dupuytren, Harris, Baron, Fleischer, Morrison, and others, sufficiently attest the danger of surgical interference in this form of aneurism, especially when the disease is chronic, and accompanied by great enlargement of the vessels, extend-ing far beyond the original seat of the affection. Even, however, in recent cases, ligation of the principal artery is by no means devoid of risk, since the effect is to deprive the parts in the distal portion of the limb of an amount of blood which they can ill spare. Another source of danger in all cases of aneurismal varix is the diseased and attenuated condition of the arteries, causing their coats to yield readily under the slightest pressure of the ligature. Finally, I may mention, as another source of risk after the Hunterian operation, the difficulty which the blood experiences in forming a firm clot, owing to the fact mainly, if not exclusively, that blood is still freely sent into the artery by the associate vein after the application of the ligature.

The danger of secondary hemorrhage after such an operation is well illustrated in a case of aneurismal varix, in the stump of the thigh of a man, twenty-eight years of age, for whose relief in 1870 I ligated the femoral artery a short distance below Poupart's ligament. The thigh had been amputated six years previously by the circular method, three inches above the knee. The stump was eleven inches in length, very conical, greatly atrophied, and the seat of constant throbbing pain, rendering the use of an artificial limb impracticable. The femoral artery and vein were greatly enlarged as high up as the brim of the pelvis, while the vein, just above the end of the stump, was expanded into a convo-luted pulsating tumor, nearly the size of an ordinary fist. Pressure upon the artery below the groin completely arrested the pulsation in the tumor and also the aneurismal thrill. A vertical incision two inches in length, commencing twelve lines below Poupart's ligament, exposed the artery, which was then cautiously isolated, and encircled with a silk ligature loosely tied over a cylinder of adhesive plaster resting upon the skin exterior to the wound, which was united by four sutures. The object of this procedure was to remove the liga-ture as soon as a firm clot should form, but no clot of any kind was developed, and the man died, completely exhausted, of repeated attacks of hemorrhage, nine days and a half after the operation, the first bleeding having occurred at the end of the sixth day.

In view of all these circumstances,—the changed condition of the bloodvessels, the imperfect circulation in the distal portion of the limb, the difficulty of obtaining a firm clot after the ligation of the main artery, and the fact that patients thus affected occasionally live for many years in comparative comfort, with the additional knowledge that a spon-taneous cure now and then occurs, and that the disease if left to itself, rarely causes death— I am satisfied that the Hunterian operation for the relief of aneurismal varix should be abandoned as an unjustifiable measure. In desperate cases involving the distal portion of a limb, and attended with intolerable suffering, amputation is, of course, the only resource.

SECT. VII.—ANEURISM OF PARTICULAR ARTERIES.

ANEURISM OF THE THORACIC AORTA.

The merest glance at the situation of this vessel is sufficient to impress us with the great importance of its relations, and to show that any deviation from its normal con-dition, however slight, may be productive of the most fatal consequences.

The disease may exist, 1st, as a fusiform expansion; 2dly, as a dilatation of the coats of

the vessel, affecting the greater portion, if not the whole, of its circumference; or, 3dly, as a true, false, or mixed aneurism, properly so called, of variable size and shape, generally connected with the anterior or lateral aspect of the artery, the posterior being seldom implicated. The ascending portion and arch of the aorta, especially the latter, are by far the most frequent seats of the disease, owing to their vicinity to the heart, which thus imparts to them its impulsive and expansive movements, and to their greater proneness to fatty and other degenerations, rendering their tunics weak and brittle, and, consequently, liable to laceration. Of 703 cases, collected by Dr. Sibson, of London, 87 occurred in the arch of the aorta within the pericardium, and 193 on the outside of this bag. The ascending and transverse portions were affected in 140 cases; the transverse alone in 120 cases; and, conjointly with the descending aorta, in 20 cases; the descending portion of the arch in 72 cases; and the vessel below the arch in 71 cases. The aneurism is generally of the true species, commencing as a sac-like enlargement, which, as it increases, usually inclines to the right side of the chest, and is capable of acquiring a volume equal to that of a double fist. It is soon occupied with organized clots, which occasionally, though very rarely, accumulate to such an extent as to lay the foundation of a spontaneous cure. The opening of communication between the tumor and the artery varies in size from that of a dime to that of a twenty-five cent piece.

The disease is more common in men than in women, and not unfrequently arises at a comparatively early age, as from twenty-five to thirty, in consequence, apparently, of severe straining and other bodily exertion. Mr. Hutchinson has reported a case of aneurism of the arch of the aorta in a girl four years old, probably due to ulceration caused by the pressure of an abscess. Sailors and mechanics are peculiarly liable to the disease. The remarkable frequency of aneurism of this vessel is shown by the tables of Mr. Crisp, embracing 915 cases, of which 382 affected the thoracic aorta.

The duration of thoracic aneurism varies from a few months to upwards of three years, the average being from nine to twelve months. The tumor usually bursts into the left pleura, pericardium, trachea, bronchial tubes, œsophagus, or posterior mediastinum; sometimes into the heart, lungs, or spinal canal; and sometimes, again, but also very rarely, externally. Dr. Darrach, of Illinois, has shown by an analysis of twenty-three cases that aneurism of the descending aorta terminates pretty uniformly by rupture, while that of the arch generally ends by exhaustion and irritation, or some concomitant disease of the heart, brain, lung, or kidney. Occasionally the tumor gives way when it is not larger than a pullet's egg. Fig. 337 represents an aneurism of the arch of the aorta which had burst into the trachea.

Fig. 337.

Aneurism of the Arch of the Aorta opening into the Trachea.

The *symptoms* of aneurism in this situation are chiefly of a mechanical character, arising from the pressure of the tumor upon the surrounding structures. They consist mainly of pain, cough, dyspnœa, dysphagia, enlargement at the sterno-clavicular region, and of various kinds of sounds, synchronous with the action of the heart.

Pain, from the constancy of its occurrence, is a symptom of great value. It comes on early in the disease, is more severe in sacculated than in fusiform aneurism, and is evidently dependent, at first, or so long as the tumor is comparatively small, upon the pressure which the aneurism exerts upon the spinal and sympathetic nerves, and afterwards upon this cause and upon the erosion and perforation of the tissues, especially the sternum, ribs, and vertebræ. It varies much in degree, character, and situation. In the earlier stages of the disease it is most conspicuous on the left side; it is sharp, lancinating, and intermittent, not unlike the pain of neuralgia, darting about in different directions; at one time into the neck and face, at another through the chest and spine, now along the shoulder and arm, and now through the diaphragm and even the loins. As the tumor enlarges, and, by its pressure, erodes the neighboring structures, the pain becomes more steady, fixed, and severe; it gradually shifts to the right side, and is generally of a burning, gnawing, or boring character.

Cough is also a common symptom; it generally begins early in the disease, and is liable to severe exacerbations, often productive of intense suffering. It is of a crowing, stridulous, or ringing character, and obviously depends upon the irritation caused by the pressure of the tumor upon the air-passages. Sometimes it is short, spasmodic, and laryngeal.

The dyspnœa is always more or less distressing, especially when the disease has made

considerable progress, and is invariably aggravated by severe bodily exertion, as in walking up a hill, or ascending a flight of stairs. It is occasionally extremely violent, although the tumor may not exceed the size of a walnut, owing to the pressure which it exerts upon the trachea, or the trachea and bronchial tubes. During the latter stages of the complaint, the breathing is always so difficult as to prevent the patient from lying down, perhaps for days before he expires.

Dysphagia is seldom present until after the disease has made considerable progress, although it is sure, in the end, to become a prominent symptom; so that, ultimately, the sufferer finds it very difficult to swallow anything either in the form of food or drink.

Derangement of the functions of the stomach is frequently present, manifesting itself in a sense of fulness and oppression; flatulence, acidity, and eructations, evidently dependent upon the pressure of the sac upon the pneumogastric and sympathetic nerves. Now and then there is obstruction of the thoracic duct from the direct pressure of the tumor, interfering with nutrition, and aiding in the production of the peculiar cachexia so common in the latter stages of this disease.

It is not often that there is any external tumor, except when the aneurism points in front of the chest, as it frequently does in its latter stages, after it has partially destroyed the sternum and the ribs, or the ribs and intercostal cartilages. In the great majority of cases it shows itself on the right side of the chest from three to four inches below the collar-bone, as a pulsating swelling, lifting up the integument synchronously with the contraction of the heart, furnishing a distinct bellows, sawing, or purring sound, and being exquisitely tender on pressure. Occasionally the sac projects into the neck above the fourchette of the sternum, inclining towards the right sterno-clavicular articulation. When this is the case, it must necessarily overlap the innominate, common carotid, and subclavian arteries on the right side, and may even so effectually compress them as to cause their obliteration, although such an event is very unusual.

A distinct aneurismal sound, or purring tremor, is usually perceptible at an early stage of the disease, although it is extremely difficult, if not impossible, always to refer it to its proper source. It is synchronous with the beat of the heart, and gradually becomes more and more faint as the disease advances, in consequence of the progressive filling up of the sac by coagula.

Among the less constant symptoms are, palpitation of the heart, wheezing, panting, or asthmatic respiration, tracheal and bronchial râles, sense of constriction of the chest, œdema and lividity of the face, permanent contraction, or, more rarely, dilatation of one of the pupils, feebleness and irregularity of the pulse at the wrist, from the pressure of the tumor upon the innominate or subclavian artery, and anasarca of the extremities, especially the inferior. Alteration of the voice is by no means uncommon, and occasionally amounts to complete aphonia. In the more advanced stages of the disease there is also frequently an enlarged and varicose state of the subcutaneous veins over the upper part of the chest, generally towards the right side.

The *diagnosis* of intrathoracic aneurism is often extremely difficult; for, although the disease manifests itself by numerous symptoms, there is not a single one that can be considered as absolutely reliable. It is not surprising, therefore, that it should frequently terminate fatally, without any suspicion as to its true nature. Such an error will be most likely to happen when the tumor is small, or when it bursts into some neighboring canal before it has sensibly encroached upon the walls of the chest. As it increases in volume, its character becomes daily more and more apparent, and all doubt must, of course, vanish when the tumor points externally, although even then a careless practitioner might regard it as an abscess, and under this supposition, be perhaps even induced to open it, as I have known in two cases, notwithstanding the heaving and pulsating nature of the swelling, and the existence of all the other signs of aneurism. When the aneurism arises from the summit of the aorta, the tumor projects into the root of the neck, and may, in fact, ascend so high up as to simulate aneurism of the innominate or carotid artery. From this, however, it may generally be readily distinguished by the history of the case, by the impossibility of tracing with the finger the lower boundary of the tumor, by the dulness on percussion of the upper part of the chest, and by the presence of a larger amount of dyspnœa than usually attends cervical aneurism, particularly in its earlier stages.

The auscultatory signs rarely afford any conclusive evidence of intrathoracic aneurism. Few surgeons are able to discriminate between the sounds of the heart and those of such a tumor, and the difficulty must necessarily be much increased when, as not unfrequently happens, aneurism and cardiac disease coexist. When the heart is sound, and the aneurism has attained a considerable bulk, the diagnosis will be less ambiguous; but even

then it will require a very practised ear to detect the varying shades of difference. The sound of a thoracic aneurism is more like the purring of a cat than the clear murmur attending the first sound of the heart, and its distinctive features are still further defined by the presence of a peculiar tremor or vibratory movement. In the sacculated variety of the affection, it is often impossible to distinguish any abnormal sound whatever; at first, because of the small size of the swelling, and subsequently, because the tumor is filled with coagula, impeding if not preventing, the transmission of sound. In fusiform aneurism, and also in simple but extensive dilatation, the sound characteristic of the disease is generally easily recognized throughout its entire progress.

Gastric disturbance is generally a prominent symptom of intrathoracic aneurism, and occurring in association with dysphagia, is a sign of great value. Dr. Walter F. Atlee recently called attention to long-continued obstinate eructation as a symptom of much significance. He attended a gentleman for eighteen months on account of what appeared to be simply a rebellious attack of dyspepsia, accompanied with the most distressing flatulence and eructation. Death occurred suddenly and unexpectedly from the rupture of a circumscribed aneurism of the thoracic aorta not larger than a walnut.

Dulness on percussion, in a marked degree, can exist only in the event of the tumor being of considerable bulk; a small aneurism may be present, and even prove fatal, without any change of resonance. When there is dulness, it is always most conspicuous at the upper and middle parts of the chest.

Sometimes valuable diagnostic information may be derived from the displacement of the heart by the tumor, its pulsations being perceived in an abnormal position, where there is no evidence of pleuritic effusion or disease of the lungs to account for the change.

The precise situation of an intrathoracic aneurism is frequently, if not generally, indicated by the character of the functional disturbance. Thus, when the suffering is chiefly laryngeal, the inference is that the innominate artery, or the posterior and inferior portion of the arch of the aorta, is involved. Excessive pectoral constriction is caused when the tumor compresses the cardiac plexus, as when it springs from the ascending portion of the arch. Dysphagia denotes pressure either upon the œsophagus or upon the pneumogastric nerve, and a corresponding situation of the aneurism. When the disease produces bronchial asthma and orthopnœa, the probability is that the tumor involves the commencement of the descending portion of the arch. Permanent contraction of the pupil is caused by compression of the sympathetic nerve, as when the aneurism, arising from the superior and posterior part of the arch of the aorta or its primitive branches, projects backwards into the chest and neck.

Dr. W. T. Gardiner, of Edinburgh, who has carefully studied the nature of these functional disorders, states that "all aneurisms coming within the range of physical diagnosis, and not attended by any of the above symptoms, must necessarily arise either from the descending aorta, below the range of the pulmonary plexus, or from the upper part of the arch, projecting upwards and forwards; as it is in these situations alone that a thoracic aneurism can attain sufficient bulk to be discoverable, without involving important internal structures, and leading to very marked functional disturbance."

Among the affections with which aneurism of the thoracic aorta is most liable to be confounded are malignant tumors of the chest, especially sarcomas and lymphomas, abscess of the neck and of the anterior mediastinum, disease of the heart, as hypertrophy and valvular derangement, and aneurism of the innominate, carotid, and subclavian arteries. The best security against error will be an attentive consideration of the history of the case, and a thorough study of its progress, time often throwing more light upon the character of the malady than the most elaborate auscultatory explorations.

Dr. Drummond, of New Castle, England, has drawn attention to a sign, which, if verified by future observation, may prove to be of great value in determining the diagnosis of thoracic aneurism. It is based upon the fact that when the patient takes a deep inspiration, and then closes the mouth and expires slowly through the nose, short, puffing sounds are heard, synchronous with the systole of the heart, on auscultation of the trachea. The phenomenon is supposed to be due to the sudden systolic expansion of the sac compressing the lungs and forcing out the air.

The *treatment* of intrathoracic aneurism resolves itself into the adoption of measures to relieve the patient's sufferings rather than to cure his disease, of which there is, in any event, hardly even a remote possibility. If plethora exist, an occasional bleeding cannot fail to ameliorate, at least for a time, the pain and difficulty of breathing. The circulation should be controlled by perfect quietude of mind and body aided by the cautious use

of aconite or veratrum viride; the diet must be light and concentrated, the bowels maintained in an open state, and suffering allayed by anodynes.

When, in spite of medical treatment, the progress of the tumor is not arrested, the common carotid artery, or that vessel and the subclavian artery, may be ligated. That a reasonable hope of prolonging, and even of saving, the life of the patient, may be anticipated from these procedures, is satisfactorily demonstrated by a number of cases, which are placed before the reader in the following tables compiled by Dr. S. W. Gross.

In 11 cases the carotid has been tied for aneurism of the aorta alone, with a result of 8 recoveries and 3 deaths. The symptoms were ameliorated in every instance; life was prolonged in four cases, respectively, for four, four, four, and five months; one patient was still living at the expiration of half a year in good health, with the tumor diminished in volume and much firmer than before the operation; and the patient of Mr. Holmes was alive, and supporting herself as a nursery maid, nearly five years after the ligation. There was still considerable pulsation and thrill, and a harsh bruit in the diminished tumor. In the case of Heath the relief was marked; but the man died at the expiration of four years and seven months from rupture of the sac externally. In seven examples the left carotid was tied, and the right in four. The former were all successful, while three of the latter died.

Cases of Aneurism of the Aorta treated by Ligation of Carotid Artery.

No.	Operator.	Date.	Sex.	Age.	Result.	Remarks.
1	Montgomery	1829	M.	40	Recovered	Died in 4 months from extension of inflammation to tumor.
2	Rigen	1829	...	...	Recovered	Died in 4 months from asphyxia.
3	Tillanus	......	M.	...	Recovered	Died suddenly in 5 months.
4	O'Shaugnessy	1842	M.	42	Died	Died 10th day from rupture of sac. Galvanopuncture also employed.
5	Knowles	1867	M.	42	Died	Died on 35th day from apoplexy.
6	Heath	1872	...	...	Recovered	Died in 4 years and 7 months from rupture of sac.
7	Holmes	1875	F.	21	Recovered	In good health at end of 4 years and 10 months.
8	Annandale	1875	M.	62	Recovered	Alive at end of 6 months. Tumor smaller and firmer.
9	Bryant	1877	M.	56	Died	Died on 10th day from pyemia.
10	Barwell	1877	M.	56	Recovered	Died in 4 months from disease of kidneys and liver.
11	Ashhurst	1878	M.	...	Recovered	Died on 45th day from suffocation.

In 6 cases the carotid has been tied for aneurism involving both the aorta and the innominate artery, with a result of 5 deaths and 1 recovery. The right carotid was ligated 4 times, with 4 deaths, and the left carotid was ligated in 2 cases with 1 death. The symptoms as a rule, were improved, and the sac of the aneurism was occupied by limited clots.

Cases of Aneurism of the Aorta and Innominate Artery treated by Ligation of Carotid Artery.

No.	Operator.	Date.	Sex.	Age.	Result.	Remarks.
1	Key	1830	F.	61	Died	Died in a few hours from cerebral anæmia.
2	Campbell	1845	M.	48	Died	Died on 19th day from suffocation.
3	Pirogoff	1864	M.	...	Recovered	In two months and a half tumor smaller and pulsation weaker.
4	Pirogoff	1864	F.	...	Died	Died in 3 weeks from softening of brain.
5	Hutchinson	1866	M.	48	Died	Died in 41 days from suffocation.
6	Hewson	1867	M.	51	Died	Died on 10th day from suffocation.

The carotid and subclavian arteries have been tied for aneurism of the aorta alone in 9 cases, 7 of which recovered from the operation, and 2 died. Two patients were still living with marked relief at the expiration, respectively, of ten weeks and eight months; and life was prolonged in three for thirteen months, fifteen months, and four years and seventeen days. In one-half of the cases the tumor was supposed to be innominatal; but its true nature was disclosed after death. In the case of Hobart, the first portion of the subclavian artery was tied; in the remainder the ligature was applied to its third division.

In the case of Spier, the carotid artery was occluded by constriction with the instrument depicted at page 667, and the subclavian was tied forty-eight hours subsequently. In all of the other examples both vessels were ligated simultaneously. Dr. A. B. Mott, of New York, in 1876, ligated the subclavian of a man, forty years of age, in whom the carotid had been tied one year previously for supposed aneurism of the innominate. On death from phthisis at the expiration of three years, the ascending and transverse portions of the arch of the aorta were merely dilated, and did not contain laminated clots.

Cases of Aneurism of the Aorta treated by Ligation of the Carotid and Subclavian Arteries.

No.	Operator.	Date.	Sex	Age.	Result.	Remarks.
1	Hobart	1839	F.	25	Died	Death on 16th day from hemorrhage from carotid. First portion of subclavian tied.
2	Heath	1865	F.	30	Recovered	Death in 4 years from rupture of sac externally.
3	Maunder	1867	M.	37	Died	Death on 5th day from extension of clot to heart.
4	Sands	1868	F.	43	Recovered	Death in 13 months from asphyxia.
5	Spier	1874	M	31	Recovered	Death on the 34th day from rupture of sac externally.
6	Maury	1874	M.	45	Recovered	Death in 2 months from rupture of sac externally.
7	Barwell	1879	M.	36	Recovered	Death in 15 months from dissipation and exhaustion.
	Ledford	1880	M.	42	Recovered	Alive at expiration of 8 months.
9	Wyeth	1880	F.	42	Recovered	Alive at expiration of 10 weeks.

The carotid and subclavian arteries have been tied for aneurism involving both the aorta and innominate artery in 6 cases, with a result of 4 recoveries and 2 deaths from the operation. The deligation was simultaneous in all except the case of Bickersteth, in which there was an interval of forty-eight days. In one instance life was prolonged for three months, and in another for nineteen months. In 1868 Hodges, of Boston, tied both vessels for a supposed true aneurism of the aorta and innominate; but, on death on the eleventh day from exhaustion, the latter vessels were found to be merely dilated. In the majority of the cases, the sac was almost entirely filled with laminated clots.

Cases of Aneurism of the Aorta and Innominate treated by Ligation of the Carotid and Subclavian Arteries.

No.	Operator.	Date.	Sex.	Age.	Result.	Remarks.
1	Bickersteth	1864	M.	35	Recovered	Death in 3 months from progress of the disease. Vessels tied at interval of 48 days.
2	Barwell	1877	F.	37	Recovered	Death in 19 months from bronchitis; sac filled with fine clot.
3	Barwell	1877	M.	45	Recovered	Death in 3 months and 10 days from bronchopneumonia. Sac nearly filled with laminated clot.
4	Barwell	1877	M.	48	Died	Death in 30 hours from asphyxia.
5	Ransohoff	1879	M.	48	Died	Death on 7th day from asphyxia.
6	Palmer	1880	F.	50	Recovered	Death on 125th day from hemorrhage.

Of the 32 cases contained in the tables, 20 recovered, and 12 died. The best results were obtained from ligation of one or both vessels for aneurism of the aorta alone. The mortality after tying the carotid artery was 27.27 per cent., while it was only 22.22 per cent. after deligation of the carotid and subclavian arteries; but the former operation was the more favorable in regard to the extension of life. In the majority of all the cases the tumor was diminished in size, and the distressing symptoms were relieved, while life was prolonged in nearly one-half for several months. In two cases, the fatal result was retarded for four years, and one patient was still living at the expiration of nearly five years.

These facts are of sufficient importance, in my opinion, to warrant the surgeon, after the failure of general measures, in following the suggestions of Mr. Heath, to ligate the left carotid for aneurisms involving the left side of the aorta, and to practise simultaneous deligation of the right carotid and subclavian arteries for aneurisms involving the right side of the aortic arch, or of the aorta and the innominate artery.

In a case of tubular aneurism of the innominate and arch of the aorta, Blackman tied the subclavian artery; but death occurred on the eighth day, from hemorrhage caused by the patient jumping out of bed.

The electrolytic treatment of aortic aneurism, first practised by Ciniselli, is particularly adapted to cases in which the tumor is situated within the chest, and communicates with the aorta by a narrow opening. The insulated needles, two or three in number, should be attached to the positive pole of a battery of large electro-motor force, and the action · should be maintained for a period varying from five to thirty minutes, and be repeated as occasion may require. The results of galvano-puncture have thus far been rather encouraging, since of 27 cases collected by Dr. John Duncan, of Edinburgh, 5 were cured, 10 were relieved, 9 were unrelieved, and 3 died.

Fig. 338.

Aneurism of the Arch of the Aorta nearly filled with laminated Clots.

The insertion of iron wire, horsehair, and other foreign materials, with the view of inducing coagulation of the contents of the sac, holds out no prospect whatever for permanent relief, and has been attended with an almost invariably fatal result.

Laryngotomy has been advised when suffocation is threatened by spasm of the glottis from irritation of the recurrent laryngeal nerve, as a means of palliating suffering and prolonging life; but, owing to the difficulty of the diagnosis, it is not probable that many cases will be subjected to such an ordeal. When the constriction depends upon pressure of the aneurism upon the windpipe, such an operation would, of course, be useless.

The annexed sketch, fig. 338, from Jones and Sieveking, represents an aneurism of the arch of the aorta, the cavity of which is nearly filled with laminated clots. Nature had evidently made an effort, almost a successful one, at spontaneous cure.

ANEURISM OF THE INNOMINATE ARTERY.

The relative frequency of aneurism of the innominate artery does not admit of any definite statement, owing to the great discrepancy in our statistics. Thus, in 179 cases of spontaneous aneurism, excluding those of the aorta, analyzed by Listranc, the innominate is mentioned only four times, while the carotid is mentioned seventeen times, and the subclavian sixteen. In Mr. Crisp's table of 551 cases, embracing 234 of aneurism of the aorta, the innominate was affected in 20, the carotid in 25, and the subclavian in 23. The disease, as in the other arteries, is much more common in men than in women, and in the laboring than in the higher classes of persons. The greatest number of cases occur between the thirty-fifth and fifty-fifth years. It may exist by itself, or be associated with aneurism of the arch of the aorta, the carotid, or subclavian. The extent of involvement varies from the slightest increase of the normal size to an enormous tumor, either tubular, fusiform, or sacculated in its character. Whether every portion of the vessel is equally liable to be affected is uncertain, but observation shows that the disease is sometimes situated so low down as to become identified with the arch of the aorta, while at other times it is so high up as to extend into the carotid and subclavian. Occasionally it is limited to the middle of the vessel, each extremity retaining its healthy appearance.

Symptoms.—Aneurism of the innominate artery usually begins as a small projection at the right sterno-clavicular articulation, between the trachea and the inner edge of the sterno-mastoid muscle, immediately above the inner third of the clavicle. In some cases the patient is conscious of the moment when the accident takes place, from a feeling as if something had given way while he was shaken by a violent paroxysm of coughing or engaged in lifting a heavy weight. The tumor is at first generally very diminutive, probably not exceeding the size of a little almond, of a rounded or ovoidal shape, distinctly circumscribed, and slightly movable on pressing the finger firmly down into the hollow at the top of the sternum. It is not long, however, before it increases in volume; commonly, in fact, it grows rapidly, soon attaining a large bulk, extending upwards into the neck, and laterally towards each side, but especially towards the right, where there is

least resistance. As it progresses, it gradually pushes forwards the sterno-mastoid muscle, and even the sterno-clavicular articulation, forming thus a large prominence, beating and throbbing violently beneath the skin. Now and then, upon escaping from the chest, the tumor ascends high up into the neck, perhaps nearly on a level with the larynx, and it is then not uncommon for it to present a constricted, hourglass-like appearance, as if a cord had been drawn tightly across its middle.

Effects on Neighboring Structures.—The effects which the tumor exerts upon the neighboring parts, fig. 339, are chiefly of a mechanical character, and must be considered with reference, first, to the vessels of the superior extremity, neck, and head; secondly, the trachea and œsophagus; thirdly, the aorta, heart, and vena cava; fourthly, the nerves of the neck and chest; and, lastly, the sternum, clavicle, and ribs.

The pressure of the tumor upon the subclavian has the effect of weakening the force of the circulation at the wrist, and in some cases even of entirely sup-

Fig. 339.

Aneurism of the Innominate Artery, proving fatal by bursting into the Trachea.

pressing it. Occasionally the pulse is extremely irregular, beating not only more feebly than that in the opposite limb, but ceasing to act synchronously with it, the blood hitching and halting, as it were, on its way to the hand. Any tumor may, of course, produce such an effect, and there is, therefore, nothing characteristic in it. In aneurism of the aorta, the signs of enfeebled circulation are, as a general rule, most strongly marked on the left side, as the tumor, from its proximity to the left subclavian, exerts a more direct and controlling influence upon that vessel than it does upon the right subclavian. The pulsation of the carotid and its branches is sometimes diminished both in innominatal and aortic aneurism, but more frequently in the former than in the latter. It is, however, a rare occurrence in either case, and, therefore, of no diagnostic value.

Compression of the veins at the root of the neck, as the innominate, jugular, and subclavian, but especially the first, by impeding the return of blood to the heart, occasionally causes œdema of the right side of the head, face, and eyelids, and of the corresponding limb, extending as low down as the hand and fingers. The occurrence, however, is uncommon, and it is probable that it may be due, in part, to obstruction of the right lymphatic duct, as it lies just behind the tumor.

As the aneurism enlarges, it necessarily encroaches more and more upon the trachea, pushing it over towards the left side, and also somewhat backwards. When the displacement is considerable, the patient breathes with difficulty, and is occasionally unable to lie down, owing to the mechanical obstruction to the introduction of the air. Should the tumor be situated unusually low, or be of extraordinary size, it may compress and flatten the right bronchial tube. Dyspnœa from both of these causes, however, is less frequent in aneurism of the innominate artery than in aneurism of the arch of the aorta, as, in the latter disease, the tumor enlarges most in a backward direction, its progress forwards being interfered with by the sternum and clavicle. Displacement of the œsophagus is sometimes present in both affections, but not so often as has generally been supposed. When existing in a high degree, it may seriously embarrass the function of deglutition, especially the passage of solids.

When the aneurism occupies the inferior portion of the artery, and especially when it extends downwards into the chest, it follows, as a necessary consequence, that it must press upon the aorta, heart, and vena cava, pushing them out of their natural position, and perhaps seriously diminishing their capacity. The particular effect which such compression must exert cannot always be diagnosticated, but it is reasonable to conclude that it will manifest itself in disordered circulation, especially in tumultuous and confused cardiac action, enfeebled pulse, and more or less dyspnœa. An aortic aneurism will, of course, be more likely to produce such phenomena than an innominatal.

Pressure of the tumor upon the nerves of the neck and chest induces not only pain and cough, but gives rise, in many cases, to severe dyspnœa and dysphagia, the two latter symptoms being not always, by any means, exclusively dependent upon the displacement
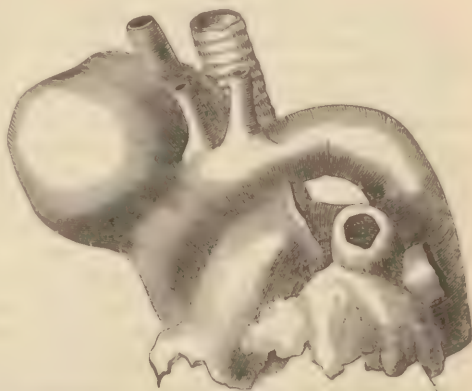
and flattening of the trachea and œsophagus. On the contrary, they sometimes exist in a very marked and even in an aggravated degree when there is apparently very little, if any, compression of these tubes. We must, therefore, look for some other explanation of these phenomena, and the most plausible one that suggests itself is that they are due to the compression of the pneumogastric, phrenic, laryngeal, and sympathetic nerves, which are thus disqualified for transmitting, in a regular and harmonious manner, their peculiar influence to the organs to which they are distributed, and in which they naturally play so important a part.

The dyspnœa, although not a constant symptom, is often enough present to render it one of great importance. It varies in degree from the slightest change in the natural respiration to the most frightful embarrassment, in which the patient is almost suffocated, and unable to maintain the recumbent posture. It is, of course, most severe and distressing when the tumor has acquired an unusual bulk, compressing the pneumogastric and other nerves, and so interrupting their healthy action. It may be constant, or paroxysmal, coming on at irregular intervals, lasting for some time, and then gradually receding, although, perhaps, at no time wholly absent.

The dysphagia is also variable in degree, being at one time very slight, and at another so severe as almost to prevent the patient from swallowing any kind of food, whether solid or fluid. In the more aggravated cases the difficulty is constant, and the patient finally dies from starvation. It is a remarkable fact that in almost every instance of dysphagia this symptom is preceded by dyspnœa.

The pain which accompanies the disease is most severe in the right side, in the situation of the tumor, from which it radiates in various directions, particularly along the right side of the neck and head, and the corresponding side of the chest, shoulder, and arm. Occasionally, although rarely, it is also keenly felt on the opposite side. It is generally of a dull, aching, or gnawing character, and is often so excessive as to require the use of large doses of anodynes for its temporary relief.

Cough is occasionally present, probably in one case out of every three or four, but it is less common than in aortic aneurism, and is a symptom of no special value. It is evidently produced by the pressure of the tumor upon the laryngeal nerves, and varies much in frequency and severity in different cases and under different circumstances. From the same cause there is sometimes an altered state of the voice.

When the tumor is very large, and extends outwards and downwards, so as to compress the cervical and brachial plexus of nerves, it may induce partial paralysis, as well as, in some cases, partial loss of sensation, in the upper extremity. Such an occurrence, however, is extremely rare, as the sac seldom attains so much magnitude.

Permanent contraction of the pupil on the affected side is occasionally noticed; it often comes on early in the disease, and is evidently due to the pressure which the tumor exerts upon the sympathetic nerve.

There is sometimes marked alteration in the respiratory sounds; more frequently, however, in aortic than in innominatal aneurism. The breathing, when affected, is disposed to be stridulous, or wheezing, and this is sometimes the case even when the patient is in the erect posture. The respiratory murmur is seldom affected in innominatal aneurism, obviously because the tumor encroaches but little, if any, upon the lungs: it is only when it extends deep down into the thorax that it is likely to produce such an effect, and then, but not otherwise, there will, also, of necessity, be dulness on percussion of the chest, over the site of the disease. Both these phenomena are more frequent in aortic aneurism, because the tumor in that disease always encroaches more upon the lungs than in the former case.

Finally, the pressure of the tumor occasionally induces serious disease in the neighboring bones, as the sternum, clavicle, and first rib, the contiguous portions of which are liable, in the first instance, to be displaced, then to become carious, and ultimately to be wholly absorbed. In some cases there is complete dislocation of the sterno-clavicular joint.

Diagnosis.—After what has just been said, it will easily be understood that the diagnosis of aneurism of the innominate artery must often be extremely difficult, its situation at the root of the neck rendering it liable to be confounded with aneurism of the arch of the aorta, the carotid, and subclavian. Then, again, certain tumors—fatty, fibrous, glandular, and cystic—sometimes form here, and receiving an impulse from the innominate, or even from the aorta itself, may thus simulate the affection in question. I have occasionally encountered great difficulty in determining the diagnosis of disease in the inferior cervical region in consequence of abnormal pulsation either of this vessel or of the aorta, apparently dependent upon an anemic condition of the system, or neuralgia of the arteries,

and so violent as to communicate a severe shock at every contraction of the left ventricle of the heart to the innominate and its two branches, the carotid and subclavian. The embarrassment, in these cases, is materially increased if, superadded to the pulsation, there is an unusual quantity of fat, or some solid growth, and the sharp thrill so common in the arteries of anemic subjects.

This difficulty was strikingly felt in a case, which occurred a few years ago in the practice of Dr. Sands, of New York, in a middle-aged woman, a patient in the Bellevue Hospital, who had a soft, pulsating tumor at the root of the neck. It was situated behind the right sterno-clavicular articulation, and extended upward two inches above the clavicle, being partly covered by the sterno-mastoid muscle. The patient was carefully examined by a number of the most eminent surgeons and physicians, who all concurred in the diagnosis of innominatal aneurism, except one, who thought that the aorta, as well as the innominate, was dilated, his opinion being founded on the presence of a circumscribed spot in the right suprascapular space, which was dull on percussion, and which transmitted, very distinctly, the aneurismal murmur. On the 16th of July, 1868, Dr. Sands, to whom I am indebted for an account of the case, performed the distal operation, by tying simultaneously the carotid and subclavian arteries. The ligature of the carotid was applied immediately above the omohyoid muscle; that of the subclavian was external to the scalene. The patient recovered from the operation, and the tumor diminished in size, the dyspnœa and other pressure symptoms being at the same time relieved, so that hopes were entertained of a permanent cure. Gradually, however, the swelling again increased, and the patient sank from dyspnœa, thirteen months after the operation. At the dissection, a sacculated aneurism was discovered, about the size of a large pear, arising by a narrow orifice from the aorta, directly in front of the origin of the innominate artery. The latter vessel was healthy, and was behind the aneurismal sac, nearly four inches from the external surface.

On the whole, the most reliable diagnostic signs of aneurism of the innominate are, first, the situation of the tumor at the right sterno-clavicular joint, immediately above the inner third of the clavicle, where it forms a distinct, well-marked prominence; secondly, stoppage of aneurismal beat, thrill, and bellows sound by pressure upon the carotid and subclavian; and, thirdly, unnatural weakness of the pulse at the right wrist, with pain and œdema on the corresponding side of the neck, shoulder, and arm. In aortic aneurism, the tumor seldom projects sensibly above the sternum; certainly not before it has attained considerable bulk, and then it is situated rather in the middle line than on the right side; the arterial pulse, if affected at all, is weakest on the left side, and there also the œdema and pain are most conspicuous; the dyspnœa, dysphagia, cough, stridulous respiration, and change of voice are more frequent than in the innominatal disease; and compression of the carotid and subclavian produces no diminution in the sounds of the tumor.

The prognosis of brachio-cephalic aneurism is extremely unfavorable. The disease, it is true, may last for a considerable time, but this is very unusual; in general, it progresses very rapidly, and soon reaches a fatal crisis, the tumor either opening externally, into the trachea, or into the chest, or else, as is commonly the case, wearing out the patient by constitutional irritation, asphyxia, or inanition. No instance of spontaneous cure has ever been known to occur in this disease.

Treatment.—The treatment of aneurism of the innominate has hitherto been most unsatisfactory. Owing to the short and stunted character of this vessel, and the close proximity of the aneurism to the arch of the aorta, deligation on the Hunterian principle is, of course, altogether impracticable, and hence the only resource is either to treat the disease upon the plan of Valsalva, or to tie the carotid and subclavian at the distal side of the sac, according to the method originally suggested by Brasdor. The treatment of the Italian surgeon holds out but little encouragement, the disease generally going on from bad to worse until it reaches its fatal crisis, despite the most abstemious course of dieting, rest in the recumbent posture, the use of the lancet, and the exhibition of digitalis, opium, and acetate of lead, to promote the formation of clots. With the exception of Mr. Luke's case, there is hardly an instance upon record in which it was followed by any ultimate benefit. Squeezing the tumor, if practicable, would certainly not be justifiable, as the detached clots might, and probably would, fall into the aorta, and thus cause serious, if not fatal, results on the spot, from mechanical obstruction to the circulation. The operation of Brasdor has been performed in a number of cases, which will be placed before the reader in tabular form.

In 3 cases the carotid and subclavian have been tied successively, as recommended by Mr. Fearn, of Derby, England, with 3 deaths.

Cases of Aneurism of the Innominate treated by Consecutive Ligation of the Carotid and Subclavian Arteries.

No.	Operator.	Sex.	Age.	Carotid ligature.	Subclavian ligature.	Remarks.
1	Fearn	F.	28	August 30, 1836	August 2, 1838	Died from pleurisy nearly four months after second operation. The aneurismal sac was found filled with dense, organized coagula, except a channel the size of the artery for the passage of blood.
2	Wickham	M.	55	Sept. 25, 1839	Dec. 3, 1839	The aneurism increased, and burst with mortal hemorrhage 63 days after the second operation.
3	Malgaigne	M.	...	March, 1845	October 17, 1845	Four days after the operation the tumor increased rapidly in size, the tumefaction became diffused, and the patient died on the 7th Nov. At the autopsy, the sac could not be dissected; it was confounded with the muscles; in other words, the aneurism was diffused.

In 14 cases the carotid and subclavian have been tied simultaneously, with a result of 7 recoveries and 7 deaths from the operation. Two patients were still living with alleviation of the symptoms and decided diminution in the size of the tumor, at the expiration respectively, of three and a half and ten months; and life was extended in one for twenty-two months, and in another for three years and four months, when, on death from phthisis, the sac in both cases was found to be almost filled with firm, laminated clot.

Cases of Aneurism of the Innominate treated by simultaneous Ligation of the Carotid and Subclavian Arteries.

No.	Operator.	Date.	Sex.	Age.	Result.	Remarks.
1	Rossi	1843	...	...	Died	Death on 6th day from cerebral anemia.
2	Lane	1871	F.	40	Recovered	Death in 3 months from rupture of sac.
3	Holmes	1871	M.	50	Recovered	Death on 55th day from rupture of sac.
4	McCarthy	1872	M.	...	Died	Death on 15th day from hemorrhage from subclavian.
5	Ensor	1874	M.	50	Died	Death on 65th day from hemorrhage from sac through carotid wound.
6	Eliot	1876	M.	41	Died	Death on 26th day from repeated hemorrhage from ruptured sac.
7	Weir	1876	M.	45	Died	Death on 15th day. Aneurism had burst into trachea.
8	King	1876	M.	37	Recovered	Death on the 111th day from rupture of sac.
9	Little	1877	M.	46	Recovered	Death from phthisis in 3 years and 4 months.
10	Stimson	1879	M.	34	Recovered	Patient died of phthisis at expiration of twenty-two months.
11	Barwell	1879	F.	27	Recovered	Patient alive at expiration of ten months.
12	Durham	......	...	...	Died	Death on 6th day from shock.
13	Pollock	1881	M.	37	Died	Death on 10th day from dyspnœa.
14	Browne	1881	M.	32	Recovered	Pulsation diminished, and bruit and pain had disappeared at expiration of three months and a half.

In 4 cases the subclavian alone has been tied, with a result of 3 recoveries and 1 death from the procedure. In the successful cases there was marked improvement in the symptoms, and life was prolonged in one instance for three years.

Cases of Aneurism of the Innominate treated by Ligation of the Subclavian Artery.

No.	Operator.	Date.	Sex.	Age.	Result.	Remarks.
1	Wardrop	1827	F.	45	Recovered	Death in 2 years from dropsy.
2	Langier	1834	M.	57	Died	Death in 1 month from asphyxia.
3	Broca	1862	M.	50	Recovered	Death in 6 months from gangrene of lung.
4	Bryant	1871	M.	33	Recovered	Death in 3 years from dyspnœa.

The common carotid artery alone has been tied in 20 cases, of which 5 recovered and 15 died.

Cases of Aneurism of the Innominate treated by Ligation of the Carotid Artery.

No.	Operator.	Date.	Sex.	Age.	Result.	Remarks.
1	Mott	1820	M.	60	Died	Death on 20th day from hemorrhage.
2	Evans	1828	M.	30	Recovered	Patient alive at expiration of 34 years.
3	Mott	1829	M.	55	Recovered	Death in 7 months from asphyxia.
4	Neumeister	1830	M.	51	Died	Death on 5th day from cerebral complications.
5	Morrison	1832	M.	42	Recovered	Sudden death in 20 months.
6	Scott	1834	...	...	Recovered	Death some time after from rupture of sac.
7	Dohlhoff	1837	F.	...	Died	Death on 6th day from cerebral complications.
8	Fergusson	1841	M.	56	Died	Death on 7th day from pneumonia.
9	Porta	1842	...	...	Died	Death in 40 hours from erysipelas.
10	Hutton	1842	M.	47	Died	Hemorrhage on 22d day. Rupture of sac into trachea on 76th day.
11	Vilardebo	1843	M.	70	Died	Death on 21st day from hemorrhage.
12	Wright	1855	M.	70	Died	Death on 88th day from abscess of brain.
13	Ordile	1859	...	...	Died	
14	Broadbent	1860	M.	50	Died	Death on 115th day from hemorrhage.
15	Butcher	1867	M.	42	Died	Death in 88 hours from dyspnœa.
16	Newton	......	M.	...	Died	Death on 12th day from effusion into the chest.
17	Pirogoff	......	M.	...	Recovered	Patient alive at expiration of two months and a half.
18	Nussbaum	......	...	...	Died	Death from rupture of sac.
19	Nussbaum	......	...	...	Died	Death from rupture of sac.
20	Bryant	1880	M.	40	Died	Death on 19th day from dyspnœa.

A careful examination of the above cases affords the following conclusions concerning the deligation of the primitive carotid for the cure of innominatal aneurism:—

1. It reduces the volume of the tumor. Thus, in the case of Mr. Evans, of Derby, in 1828, although the aneurism was as large as a walnut, it entirely disappeared in a little upwards of a month. In Dr. Mott's second case, in 1829, it was of the size of a pigeon's egg, and disappeared in twenty-six days.

2. The operation leads to fibrinization of the contents of the sac. These changes, which are due, not to arteritis, but to remora of the blood, were well displayed in the cases reported by Mr. Morrison, of Buenos Ayres, in 1832, Sir William Fergusson, in 1841, and Dr. Wright, of Montreal, in 1855. In the first, the innominate artery was larger than natural; and in all, the tumor was nearly filled with firm clots.

3. The operation is attended with certain risks; but the deaths were due not, apparently, to any agency of the aneurism, but to the danger which naturally succeeds to the ligation of the common carotid, for whatever purpose. Thus, in the instances of Mott, Vilardebo, and Broadbent, death resulted from secondary hemorrhage. In the case of Fergusson, the patient died of pneumonia; and in the case of Porta the fatal result was due to erysipelas. In the instances of Hutton, Scott, and Nussbaum, the cause of death was rupture of the sac, also a very common effect of the operation for carotid aneurism, whether the ligature be placed above or below the tumor. In two instances, those of Neumeister, and Dohlhoff, the patients died of the effects of ligation of the artery upon the brain; and in that of Wright, death was due to abscess of the brain.

4. The operation has not been productive of a long after-life, chiefly, perhaps, because the cases demanding it were nearly all inherently hopeless, from being associated with organic disease of the aorta, or of this vessel and of the heart. Distinct evidence of this fact existed in at least seven of the cases; in the rest no accurate examination was made. The influence of such complications is shown by the results which followed Brasdor's operation in aneurism of the root of the carotid unmixed with any other lesion. Of eight cases of this kind, six completely recovered, and two died.

5. The operation lengthens life if perilled by rupture of the sac, or pressure on the windpipe. In fact here is its great triumph. In the case of Professor Wright, although the man was in imminent danger before the operation, yet he survived it eighty-eight days. The mean duration of life after deligation of the carotid, under ordinary circumstances, is about four months and a half.

6. The operation has occasionally failed to effect any local improvement. This result

followed in several of the cases, in consequence of a want of fibrinization of the contents of the sac.

The facts above stated, deduced mainly from the paper of Professor Wright, in the Montreal Journal of Medicine, clearly point, as that gentleman justly remarks, to a division of cases in regard to the applicability of the operation. 1. The most suitable cases are those of uncomplicated innominatal aneurism, being akin to the pure carotid form, the sac, which is confined to the part of the vessel near the bifurcation, springing from the left segment of the artery, and not coexisting with degeneration of its tunics or cardiac disease. 2. Those imperatively requiring it are such as entail imminent danger from external rupture of the tumor or from other causes. 3. The most favorable cases are aneurisms proceeding from the left segment of the artery, because then the introduction of blood into the sac is most effectively impeded, as it is derived from the current destined for the vessel which is tied, whereas, when the aneurism is dextro-lateral, the same benefit cannot be afforded, as the supply is furnished by the subclavian. Next to this situation, the most preferable, anatomically, would be the origin of the tumor from the anterior circumference of the vessel. 4. The less advantageous cases are those in which the external tumor extends towards the middle of the clavicle, for this occurrence denotes such an engagement of the subclavian as must effectually counteract any benefit derivable from ligature of the carotid. When the swelling is equal on each side of the innominate, or symmetrical, then the only hope of a certain stasis of blood would be afforded by tying both branches. 5. The cases contraindicating the operation are those having complications with aortic aneurism, or serious disease of the heart, unless excepted by extreme urgency.

ANEURISM OF THE COMMON CAROTID ARTERY.

Spontaneous aneurism of this vessel is less frequent than is generally supposed, owing, doubtless, to the fact that it is so seldom the seat of the fatty and calcareous degenerations. Of 551 cases of aneurism of different parts of the body, embracing 234 of the aorta, the carotid is stated by Mr. Crisp to have been affected in 25, or in the ratio of 1 to 22. Of 179 cases analyzed by Lisfranc, 17 refer to the carotid, 16 to the subclavian, 14 to the axillary, 26 to the femoral, and 59 to the popliteal. The disease in 47 involved the aorta.

The affection is much more frequent in men than in women, in the proportion of about three to one. Thus, in the statistics of 712 cases out of 789, compiled by Dr. Wyeth, in which the sex is stated, 538 were males, and 174 were females.

Age exerts a marked influence upon the production of the disease. The period of life from the twentieth to the fortieth year furnishes the greatest number of cases. It is occasionally witnessed at a very early age. Wyeth's tables comprise 16 cases under twelve months, and 22 cases under ten years. Although the fact is not stated, it is evident that most of these cases must have been of traumatic origin or of an anastomotic nature. The disease occurs with nearly equal frequency on both sides, and, in fact, sometimes exists simultaneously in both arteries. No occupation is exempt from it.

The site of carotid aneurism is variable. Sometimes the tumor is situated very low down in the neck, close to the origin of the vessel; on the other hand, it may be high up, near its bifurcation. In the great majority of cases, however, it will be found to be between these two points, or near the middle of the artery; usually rather above than below.

Symptoms.—The tumor, when first observed, is generally quite small, perhaps not exceeding the size of a filbert, and of an irregularly globular, rounded, or ovoidal shape. The patient, upon being questioned as to the history of the case, usually expresses his ignorance as to the time of its occurrence, though occasionally he is rendered conscious of it by a peculiar stabbing sensation in the neck, or a feeling as if something had suddenly snapped asunder. Commonly the surgeon is not consulted until the tumor has made considerable progress, and acquired the volume of a hen's egg, or of a small orange, the patient, perhaps, having all along supposed that the swelling was merely an enlargement of some of the cervical glands. A careful inspection, however, promptly reveals its true character, its pulsation, thrill, and bellows sound affording unmistakable evidence of its close and intimate arterial connection. Pressure upon the cardiac side of the aneurism, by stopping its circulation, arrests these symptoms, and causes a sensible diminution of the size and consistence of the tumor, while pressure upon its distal side produces an opposite result. As long as it is small, the tumor may readily be moved

about, and even raised out of its bed, especially if it be grasped with the thumb and forefinger during the relaxed condition of the sterno-mastoid muscle; as it augments in volume it becomes more fixed in its position, and is eventually rendered almost, if not entirely, stationary.

The symptoms of carotid aneurism are mainly of a mechanical character, being such as arise from the pressure of the tumor upon the neighboring parts; hence, their gravity is generally in proportion to the volume of the morbid growth. In the earlier stages of the disease, there is either no functional disturbance whatever, or it is so insignificant as not to attract any special attention; by and by, however, as it progresses, the tumor necessarily encroaches more and more upon the delicate and important structures of the neck, thus occasioning congestion of the brain by retarding the return of the blood in the jugular vein, numbness, pain, and cough, by compressing the cervical, pneumogastric, and phrenic nerves, and difficulty of respiration, and, perhaps, even of deglutition, by bearing against the trachea and œsophagus. The surface of the swelling, at first perfectly natural, becomes gradually indurated and inflamed, the subcutaneous veins are unusually conspicuous, and the neck is stiff, distorted, and almost immovable. The greatest enlargement of the tumor is generally in the direction of the middle plane, as the resistance is much less there than externally, under the edge of the sterno-cleido-mastoid muscle.

Diagnosis.—Notwithstanding that the symptoms of carotid aneurism are usually well marked, cases, nevertheless, occur in which they are so obscure as to render it extremely difficult to determine the diagnosis, even after the most careful and patient investigation. The affections of the neck which are most liable to be confounded with carotid aneurism, and to render the discrimination doubtful, are diseased lymphatic glands, abscesses, cystic tumors, goitre, dilatation of the internal jugular vein, and aneurism of the innominate artery and arch of the aorta.

Enlargement of the *lymphatic glands* of the neck is most common in young subjects, before the age of twenty, whereas aneurism of the carotid is rarely met with until after thirty; moreover, it is almost peculiar to scrofulous persons, while aneurism occurs in all classes of individuals, the strumous and the non-strumous. In aneurism the tumor is generally well defined; its surface is smooth and uniform, and the swelling heaves and throbs, as if it were alive. In glandular enlargement, there is generally a chain of diseased glands, either scattered about in different parts of the neck, or stretched along the inner border of the sterno-cleido-mastoid muscle; the tumors feel hard, and may, with a little care, be easily separated, not only from each other, but from the carotid artery, so as to get entirely beyond the reach of its pulsation.

An aneurism of the carotid artery has sometimes been mistaken for an *abscess;* the tumor has been punctured, and the patient has speedily perished of hemorrhage. Such an error, of course, implies great carelessness, and could hardly happen at the present day, when our means of diagnosis are so much more perfect than they were formerly. The discrimination must be determined on general principles. If there is an abscess, the history of the case, conjoined with the unnatural heat and redness of the part, the rapid progress of the swelling, the febrile disturbance, and the absence of the characteristic pulsation, thrill, and bellows sound, will be sufficient to distinguish it from aneurism of the carotid artery.

Cystic tumors, usually containing a serous or sero-sanguinolent fluid, are liable to form at the front and sides of the neck, most generally in connection with the thyroid gland, but sometimes independently of it, in the connective tissue beneath the muscles. They may usually be readily distinguished by their slow growth and fluctuating feel, the absence of pain and pulsation, and, when they are attached to the thyroid gland, by their obeying the movements of the larynx in the act of deglutition. If, after a careful examination of their history, any doubt exists as to their real nature, the only resource will be the cautious introduction of the exploring needle.

Goitre is liable to be mistaken for carotid aneurism only when it spreads laterally over the neck, so as to overlap the carotid, and receive its pulsation. It is certainly not possible to commit any error of diagnosis in the more ordinary and simple forms of the disease. Confusion is most apt to arise when aneurism and goitre coexist, or when, as occasionally happens, the latter disease is developed uncommonly rapidly, and is attended with considerable local distress. Ordinarily, goitre forms in early life, at a period when aneurism is extremely infrequent; it is generally tardy in its progress, several years elapsing before it attains any material bulk, and it is subject to occasional interruptions, and even total suspension, whereas aneurism generally advances rapidly

and steadily, the symptoms proceeding from bad to worse, until it attains its crisis. Another important criterion is the fact that goitre is almost peculiar to females, whereas carotid aneurism occurs by far most frequently in men. But the most satisfactory diagnostic signs are, first, that in goitre, the tumor obeys the movements of the larynx, whereas in aneurism it remains stationary, however strong the efforts at deglutition ; secondly, that in the former the tumor may be drawn away from the vessel, raised up or pushed to one side, while in the latter the vessel follows it, forming, as it does, a part of it ; and, lastly, that in goitre the general health rarely suffers, even when the tumor is of large bulk, whereas in aneurism it is always more or less impaired, especially when it has reached such a stage as to be likely to occasion embarrassment in regard to the discrimination between the two affections.

A dilated condition of the internal *jugular vein* may simulate aneurism of the carotid artery. The deception will be the more likely to happen if the vein receive a pulsatory movement from the heart or from the carotid, as when the artery is overlapped by the vein. The venous tumor may generally be distinguished by its softness and compressibility, by its situation, which is commonly just above the sternum, and rather behind than in front of the sterno-cleido-mastoid muscle, and by the circumstance that its motion is more of an undulatory, wave-like, or tremulous character, than shock-like and vibratory, as in aneurism. Superadded to this is the fact that the venous swelling may readily be effaced by pressure applied to its distal extremity, whereas, in aneurism, the pressure, to produce any appreciable effect of this kind at all, must be applied to the cardiac extremity of the tumor, and then it will result only in a diminution, not in complete obliteration.

Finally, a carotid aneurism may be confounded with aneurism of the *innominate artery*, or of the arch of the aorta, especially if it be situated low down in the neck. When this is the case, the difficulty may be very great, if not insurmountable. The most reliable diagnostic sign with which I am acquainted, and one that will rarely fail, in such an emergency, is afforded by our ability to insinuate the point of the forefinger between the top of the sternum and the lower extremity of the aneurism, while the head is being bent powerfully forwards, so as to relax as fully as possible the sterno-mastoid muscles. If this can be done, the probability is that the tumor is connected with the carotid ; otherwise it may be inferred that it is formed by the innominate artery, or by the arch of the aorta.

Several examples have been recorded in which aneurism of the *vertebral artery* was mistaken for aneurism of the common carotid, the latter vessel having actually been tied for the relief of the disease. All the cases, about four in number, proved fatal.

Progress.—The progress of carotid aneurism, although usually rapid, is not so always. The annals of surgery contain several cases where the disease remained almost stationary for a considerable number of years ; in one as many as fourteen. A spontaneous cure sometimes occurs, but such an event must necessarily be extremely rare. The tumor, if allowed to go on unchecked, eventually, generally at a period varying from three to twelve months, destroys life either by excessive constitutional irritation, hemorrhage, gangrene, pneumonia, or asphyxia. When seized by ulceration, it may burst either externally, or it may open into the pleura, the anterior mediastinum, the trachea, or one of the bronchial tubes. Esmarch and Teale have each related a case of fatal embolic apoplexy from the detachment of fibrinous clots in an aneurism of the common carotid artery, from pressure exerted upon the tumor with a view of ascertaining its real character.

Treatment.—The treatment of carotid aneurism is generally conducted according to the Hunterian principle of ligating the supplying vessel at the cardiac side of the tumor; and, fortunately, as the disease is ordinarily situated rather high up, this may commonly be done without any very great difficulty, especially in the earlier stages of the affection, before the swelling has attained much bulk. When the tumor is of great size, or located at the inferior part of the neck, we may be compelled to adopt the method of Brasdor, and tie the carotid on the distal side of the aneurism, trusting that the blood in the tumor, no longer finding an outlet, will gradually coagulate, and so effect its obliteration. The fact is, this artery, owing to the total absence of collateral branches, is peculiarly adapted to this operation, and it is well that it should be so, seeing that, if it were otherwise, we should be obliged to resign many of the more severe cases of carotid aneurism to their fate, without any attempt whatever at surgical interference. It is obvious, from the relations of the vessels and nerves of the neck to the tumor, that compression, now so much employed in the treatment of aneurism of the lower extremity, can seldom be

brought into play here, the parts being intolerant of the requisite manipulation, to say nothing of the obstruction which it would occasion to the return of the blood in the internal jugular vein, which, being dammed up in the brain and the sinuses of the dura mater, might speedily induce apoplexy, or other serious cerebral symptoms, endangering the patient's life. When the tumor is of extraordinary bulk, rendering ligation of the carotid impracticable at any point, our only hope, faint though it be, is the success of general measures, particularly Valsalva's method; for experience has conclusively proved that no benefit is to be expected from the ligation of the innominate artery, as originally proposed and practised by Dr. Mott. The deligation of the terminal branches of the carotid might be tied with a better prospect of success, but this also would be likely to fail, owing to the numerous offsets of the external carotid, which, unless included in separate ligatures, would continue to transmit the blood from the tumor with sufficient force and activity to maintain its circulations unimpaired, and so inevitably frustrate the intentions of the operation.

When the tumor is unusually voluminous, or even of moderate size, but situated very low down, overlapping and compressing the trachea, the symptoms may be so urgent as to demand the operation of laryngotomy, to save the patient from impending asphyxia. Such an event must, however, be very uncommon.

A very interesting case of carotid aneurism has been related by Dr. Robertson, of Edinburgh, in which he performed an operation after the tumor had burst into the œsophagus. The swelling was situated so low down that he was compelled to ligate the vessel only half an inch above its origin from the innominate artery. Notwithstanding these unfavorable circumstances, the patient made an excellent recovery, the ligature coming away on the seventeenth day.

The operation of tying the carotid is ordinarily easy enough, but when the aneurism is large, or the neck very short and fat, it is one of the most difficult and trying undertakings in surgery. The principal accidents likely to attend it are the inclusion of the jugular vein and pneumogastric nerve in the ligature, and the wounding of some of the smaller vessels of the neck, which it is sometimes more difficult to find and secure than the carotid itself.

The old procedure of laying open the sac, turning out its contents, and tying both ends of the vessel, was practised by Mr. Syme, in a case of traumatic aneurism of the lower part of the left carotid, the result of a stab two months previously. A small incision being made into the tumor, the finger was passed in so as to plug the puncture, and then the point was carried about till it hit the precise spot where pressure controlled the pulsation. The sac was now freely opened, the clots sponged out, and a ligature applied to each end of the vessel. In this part of the operation great annoyance was experienced on account of the difficulty of finding the orifices of the artery, and it was not until after the division of the sterno-cleido-mastoid that the object could be attained, such was the confused condition of the inner surface of the sac. The patient, notwithstanding his apparently desperate condition, made an excellent recovery. This bold operation was successfully imitated, in 1875, by Dr. Frothingham, of Ann Arbor, in a similar case, in which he emptied the sac, and tied the artery at both ends. Such an operation, it is evident, can be performed only by a surgeon of consummate ability, with thorough anatomical knowledge, and the most perfect self-possession. In the hands of a less competent man it might instantly be fatal.

Mortality and other effects.—Of the mortality of the operation for carotid aneurism, a tolerably accurate estimate may be formed from the data now before the profession. Of 21 cases mentioned by Mr. Crisp, 10 were successful, and 11 fatal. In 5, the artery was ligated at the distal side of the tumor, and of these, 3 recovered, the other 2 being only somewhat benefited. Of the 11 fatal cases, 5 were lost by hemorrhage, 2 by inflammation of the sac and artery, and 1 by spasm of the glottis, the cause of death in the remaining 3 being doubtful. The table of Dr. Norris contains an analysis of 38 cases, in which the carotid was tied for aneurism, including 4, however, in which the disease was found, after the operation, not to have been connected with the artery. Of these cases, 22 recovered, and 16 died. The cause of death is mentioned in only 12 of the cases; in 5 it was hemorrhage, in two inflammation of the sac, in 2 apoplexy and congestion of the brain, in 1 cerebritis, in 1 spasm of the glottis, and in 1 exhaustion.

In 6 of the 38 cases, the aneurism suppurated, and either burst or was laid open; of these, 4 died and 2 recovered. In one instance the opening in the sac occurred four months, and in another nearly eight months, after the operation. In one fatal case, the tumor burst into the pharynx fifteen days after the deligation of the artery, and in

another case, which, however, recovered, it had discharged some of its contents into the mouth prior to the operation.

Return of pulsation in the tumor, after the operation, was noted in 9 of the 38 cases; in one the pulsation never ceased entirely for two months, and in another it continued for upwards of four months.

The detachment of the ligature occurred, in 13 cases, before the twentieth day; in 7, between the twentieth and thirtieth, and in 1 on the thirty-third day. The time in the remaining cases was not observed.

In seven of the cases, analyzed by Dr. Norris, there was a mistake in the diagnosis, as was proved on the dissection, for all the patients died. In four, the disease consisted of different kinds of tumors; in two, of aneurisms supposed to be abscesses; and in one of an aneurism of the vertebral artery. The examples of mistaken diagnosis include the celebrated case of Mr. Liston, of a lad, nine years of age, who had a tumor on the right side of the neck, of two months' standing, which, although seated over the carotid, was entirely free from pulsation, except along the track of that vessel. Under the conviction that it was merely an abscess, a bistoury was introduced, the removal of which was followed by a gush of arterial blood to the amount of four ounces. The bleeding being arrested by closing the wound with the twisted suture, the common carotid was tied on the following day, October 21st, close to its origin from the innominate artery. On the 3d of November, the arterial hemorrhage suddenly recurred, but was suppressed by plugging the wound with lint; it, however, again broke forth, and proved fatal on the 5th, that is, fifteen days after the operation. Although the ligature had retained its hold upon the artery, the proximal end of the vessel was found to be quite patulous, no attempt having been made at the formation of a coagulum. The probability is that, as Mr. Liston has suggested, the tumor, in this remarkable case, was originally a scrofulous abscess, a part of the wall of which was formed by the carotid; the latter, becoming ulcerated, finally gave way, and thus sent its contents into the cyst inclosing the matter.

Of 16 cases of ligature of the common carotid artery on the cardiac side of the tumor for aneurism of the common carotid alone, analyzed by Wyeth, 9 recovered and 7 died. Distal ligature of the vessel for aneurism of the root of the common carotid has been practised 8 times, with a result of 6 recoveries and 2 deaths. The case of Demmé is excluded, as the arch of the aorta was also involved. The operation was first resorted to by Wardrop, in 1826, and this patient was alive three years afterwards.

Injury to the internal jugular vein has been a cause of death in several cases of ligation of the carotid. In one in which Barovero included this vessel with the artery, the patient died on the sixty-ninth day of gastric fever. Mr. Crisp met with an instance where a surgeon tied the internal jugular vein instead of the carotid; the patient was a child, and the error was not discovered until after death. Fatal results have occurred several times from injury done to the pneumogastric nerve in ligating this artery.

Various serious cerebral and pulmonic symptoms occasionally follow the ligation of the carotid artery, and are among the principal sources of the mortality from this operation.

The effects which the operation produces upon the *brain* have been elucidated both by experiments upon the inferior animals and by observations upon the human subject, and manifest themselves in various ways and at different intervals. Their full importance, however, was not determined until after the publication of the researches of Mr. Chevers, of London, in 1845, to whom the profession is greatly indebted for the valuable light which he has thrown upon a subject which, up to that period, had been entirely overlooked. In the 789 cases analyzed by Dr. Wyeth, in which the common carotid was tied either for aneurism, wounds, or other causes, more or less severe cerebral disturbance occurred in 52. Some of these cases recovered completely, some got well of the operation, but remained afterwards in a crippled condition, and some, perhaps the majority, died, at a period varying from a few hours to several months.

There is no uniformity either in the character or in the manifestation of the cerebral symptoms. Sometimes they come on immediately, or, at all events, within a few hours, after the deligation of the vessel; while at other times, and perhaps most generally, they do not appear until the end of several days, weeks, or months. Their access is usually sudden, but occasionally so gradual and imperceptible as to keep the patient in ignorance of it until it is discovered accidentally. The most frequent symptoms are convulsions and paralysis. The former may be general, but much oftener they are partial, affecting, for example, one arm, a leg, or one side of the face; in some cases there are merely spasmodic twitches, or irregular, involuntary movements. The paralysis occasionally exists on the side of the affected artery, but in most cases it occurs on the opposite side, and

then it may pervade one-half of the body, as in hemiplegia, although generally it is more limited, being confined, perhaps, to the face, tongue, throat, fauces, eyelid, hand, arm, leg, or thigh.   Sometimes there is dimness of vision, with or without dilatation of the pupil; a feeling of drowsiness, somnolency, stupor, or coma; dizziness, vertigo, or headache; noise in the ears or partial deafness; delirium, either alone or conjoined with paralysis or convulsions; difficulty of deglutition; dyspnœa; a sense of coldness, or coldness and numbness.   Various other symptoms, mostly of an anomalous, nervous character, are often present.   Occasionally these effects rapidly disappear, but, in general, they are more or less persistent, and in some cases they remain up to the moment of the patient's death.   In some instances, inflammation of the brain, or of the brain and its envelopes, supervenes, either soon after the deligation of the vessel, or at a more or less remote period.

How are these phenomena produced?   Are they caused merely by an inadequate supply of blood to the brain, or are they due solely to a loss of equilibrium in the cerebral circulation?   To answer these questions satisfactorily is of course impossible.   It would seem probable, from the free anastomosis which exists between the branches of the internal carotid arteries, on the one hand, and between these arteries and the vertebral, on the other, that they could not be occasioned by a mere want of blood, inasmuch as these vessels are capable of furnishing the organ with an abundant supply of that material for the purpose of carrying on its healthy functions.   Nevertheless, it is not likely that unpleasant effects may and do follow the sudden withdrawal of a certain quantity of blood from the brain, resembling those produced by copious bleeding at the arm, or by a smart concussion of the brain.   In some instances, it is reasonable to conclude that they are the result of the inclusion of an important nerve; while in another class of cases, as when several weeks or months elapse before their supervention, they would seem to be the direct consequence of inflammation.   Under the latter circumstances, dissection reveals softening of the cerebral substance and effusion of serum, or of serum and lymph, in the ventricles and upon the surface of the brain.

The most constant *pulmonary* effects occasioned by the ligation of the carotid artery are cough, bronchitis, and inflammation of the pulmonary tissue.   Cough is not only a very frequent occurrence, but often one of great severity, rendering it sometimes extremely difficult to check it.   It generally comes on soon after the operation, in fits of a violent spasmodic character, in which the patient is in the deepest distress, looking and acting as if he were about to be suffocated.   Its duration is variable; sometimes lasting only a few hours, while at other times it continues, as a prominent symptom, for days together.   When very severe, it may occasion hemorrhage in the wound, by reopening some of the vessels.   Violent hiccough sometimes follows the operation, and may last for an almost indefinite period.

It is not easy to determine how this cough is induced.   From the fact that it often follows immediately upon the operation, it is not unlikely that it may arise from the inclusion in the ligature of some nervous filament, which thus sets up irritation in the mucous membrane of the air-passages, especially of the larynx and trachea, causing an effect not dissimilar from that awakened by the sudden intromission of a drop of water into the windpipe.   That the effect must be somewhat of this character would seem probable, when we reflect upon the spasmodic and uncontrollable nature of the cough which generally characterizes the attack.   At other times, the cough may be purely sympathetic; or, what is more likely, may be caused by the compression of the filaments of the sympathetic nerve, which are so abundantly distributed through the coats of the arteries, especially those about the neck and chest.   May not the pressure of the ligature upon the pneumogastric nerve occasion this distress?

The effects which the ligation of the carotid exerts upon the bronchia and lungs set in at various periods after the operation, and are denoted by the usual rational and physical signs.   On dissection, the mucous membrane of the former is found to be of a reddish color, either uniformly or in patches, greatly engorged with blood, and covered with pus, or pus and lymph.   The lungs are abnormally vascular, loaded with black blood, more or less hepatized, or solidified at one point and softened at another.   Blood and pus are sometimes contained in the anterior mediastinum; the pleura has been known to be the seat of extensive effusions; now and then there are traces of inflammation of the larynx and trachea; and occasionally, although rarely, the examination reveals the existence of pericarditis and endocarditis.   When the inflammation of the respiratory organs is at all considerable, the blood drawn during life generally evinces a buffed, if not also a cupped, appearance.

Such being the effects which are liable to follow, probably in one case out of every four or five, in the brain and lungs, in consequence of the deligation of the carotid, it is obvi-

ous that they should be carefully looked for, in order that proper measures may be adopted for their prompt and efficient removal the moment they arise. Much may be done, in most instances, by way of prevention, by a judicious preparatory course, consisting of venesection, purgatives, light diet, and repose of mind and body, which cannot fail to contribute materially to the protection both of the brain and lungs. The operation having been performed, these organs are most sedulously watched, the least indication that presents itself being met by appropriate means, and, in this way, the case safely conducted to a favorable issue. If the patient be pale and faint, alcoholic stimulants, cautiously and judiciously administered, will be of service; cough and convulsive symptoms are treated with anodynes and antispasmodics, particularly morphia; and inflammation is controlled by the lancet, leeches, blisters, purgatives, aconite, and antimonials.

The treatment of aneurism of the carotid artery by *digital compression* has not been tried upon a sufficiently extended scale, or under sufficiently varying circumstances, to enable us to form anything like a correct estimate of its value, or of the particular class of cases to which it is applicable; but the successful examples that have been reported by Kerr, Rouge, Gioppi, Vanzetti, Sheppard, Humphry, Gay, and Sir R. Dagin, are quite encouraging, and point to the propriety of further efforts in this direction. In the cases recorded by De Castro and Delore the procedure failed. The compression must, of course, be intermittent, and the best plan is to make it laterally, the thumb being placed against the anterior border of the sterno-mastoid muscle, and the next three fingers under its posterior edge, an expedient which allows the artery to be seized and controlled without injury to the pneumogastric nerve. In Rouge's case, in which this practice was successfully pursued, the compression was continued for seventeen days, on an average of seven to eight hours each.

The heart's action should be controlled during the treatment by venesection, opium, and veratrum viride. The exhibition of acetate of lead and ergot might be of service in promoting the formation of coagula. As little pressure as possible should be made upon the internal jugular vein, otherwise the functions of the brain might be seriously disturbed. The chief objection, I conceive, to digital compression in this situation, is the danger of embolism. The sudden impaction of a clot in the internal carotid artery or in one of its principal branches might cause instantaneous death.

Aneurismal Varix.—This affection is uncommon. It is generally caused by external injury, as a puncture made by a knife, dirk, shot, or piece of glass, establishing a communication between the carotid artery and jugular vein, so as to admit of a ready interchange of their respective contents. Instances have been published in which the affection was occasioned by ulceration. The symptoms present nothing peculiar. In the few cases of this variety of aneurism that have been recorded by different observers, as Larrey, Marx, Williamson, and Rigaud, life did not seem to have been at all abridged by the disease. Operative interference would, in fact, in any event, be unjustifiable, as it would be fraught with great danger. Of varicose aneurism, properly so called, of these vessels, no instance has, I believe, ever been reported.

ANEURISM OF THE EXTERNAL CAROTID AND ITS BRANCHES.

Spontaneous aneurism of the external carotid is perhaps still more uncommon than of the internal carotid; its history, consequently is involved in obscurity. The situation of

Fig. 340.
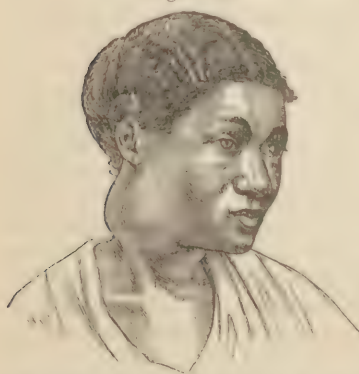
Traumatic Aneurism of External Carotid.

the tumor just below the angle of the jaw, its throbbing, pulsatile character, and its gradually increasing volume, would serve to distinguish it from ordinary growths in this portion of the cervical region. In an aneurism of this artery, digital compression would be worthy of trial; should this fail, the proper remedy would, of course, be ligation of the common carotid.

False aneurism of the external carotid is rarely met with, the only cases of which I have any knowledge being those of consecutive arterial aneurism reported by Professor Lisco, and Dr. S. W. Gross, and two examples of arterio-venous aneurism described by Rufz, of Martinique, and Gabe, of Masarellos. In the first case the old operation of opening the sac was successfully performed, but such a procedure is too hazardous to be imitated. The patient of Dr. Gross was a negress, twenty-five years of age,

who was wounded by a pistol ball, which entered the neck opposite the upper border of the thyroid cartilage. Six months subsequently a small pulsating tumor was perceived just above the bifurcation of the common carotid, which rapidly increased until it measured eight inches transversely by five inches from above downwards, and formed an extensive swelling, the external features of which are depicted in the adjoining sketch, fig. 340. The common carotid was ligated in July, 1868, and in two months the tumor had diminished at least two-thirds. At the expiration of one year not a trace of it remained.

In the case of Gabe, the tumor, of the size of a nut, was seated near the lobule of the ear, and was caused by a sabre wound. It was treated unsuccessfully by Chelius, first by compression and afterwards by ligation of the common carotid, but was finally cured by Stroymeyer by the old operation.

The *temporal artery* has never, so far as I know, been the subject of spontaneous aneurism, but an aneurism of this vessel is occasionally met with as a result of external injury. In 1868, Dr. Macnamara, of Dublin, showed me a tumor of this kind, in a man thirty years of age, on the anterior branch of the temporal artery, caused by the scarificator in cupping; and cases of aneurism of this trunk or of its offsets have also been observed by Petrequin, Decès, Malgaigne, Frestel, and Pavesi.

The tumor, rarely exceeding the volume of a pigeon's egg, is usually of a spherical shape, and situated just in front of the ear, where it can nearly always be readily distinguished by its history, by its firm consistence, by its pulsation, and by its peculiar whiffing sound. The only two diseases with which it might be confounded are cystic tumors of the parotid region and aneurism of the middle meningeal artery, attended with absorption of the walls of the cranium, the swelling thus presenting itself directly beneath the common integument.

For the cure of this disease two procedures may be employed; the one consists in exposing and tying the temporal artery at the cardiac side of the tumor, as in the ordinary Hunterian operation, and the other in laying open the sac, and, after having turned out its contents, securing the vessel above and below. The former method, when practicable, should always be preferred, as it is not only more simple, but less liable to be followed by a disfiguring cicatrice.

Gamma saw an aneurism in the *facial* artery, near the commissure of the lips; Hoefnagels, in the interior coronary; Boyer and Klaving, in the posterior auricular; Giehrl and Agnew, in the occipital; Pancoast, in the stylo-mastoid; Rutz and Heyfelder, in the inferior dental; and Castle, Herapath, Tierlinck, and I myself, in the palatine. In nearly all of these cases the tumor was of small size, and owed its origin to external injury. In the case recorded by Castle the aneurism was caused by the pressure of the plate of artificial teeth.

The *middle meningeal artery* has, in a few instances, been the seat of aneurism, the result, apparently, of external injury. The nature of the disease can be recognized only when the tumor, causing absorption of the walls of the cranium, appears externally under the temporal muscle. A case has been related in which an aneurism of this vessel, making its way into this situation, was mistaken for a common cystic tumor of the scalp. As there was no pulsation, the surgeon cut boldly into the swelling, and found, to his dismay, that it was filled with blood. After repeated but fruitless efforts to arrest the hemorrhage, the patient expired. The dissection showed that the disease had been an aneurism of the middle artery of the dura mater. Had the real nature of the case been suspected in time, the proper remedy would have been ligation of the external carotid.

Some of the branches of the external carotid artery have occasionally, though rarely, been the seat of *arterio-venous aneurism*. In a case recorded by Langier, the abnormal opening existed between the posterior auricular artery and its satellite vein. A similar example has been reported by Broca; and Moore met with one in which a communication was established between the temporal artery and the accompanying vein.

ANEURISM OF THE INTERNAL CAROTID AND ITS BRANCHES.

Aneurism of the internal carotid has been observed only in a few instances, its deep situation at the side of the neck and its exemption from ossific and fatty degeneration serving to protect it from this disease. The diagnosis must be obscure. The tendency of the tumor is to extend inwards towards the pharynx, as there is much less resistance here than in any other direction, the only opposing obstacles being the constrictor muscle, some lax connective tissue, and the mucous membrane. The consequence is that more or

less prominence exists in the throat, attended with pain and pulsation, and closely simulating an abscess of the tonsil. The treatment is the same as in ordinary carotid aneurism.

A remarkable case of aneurism of this vessel has been recorded by Mr. Syme. The patient, a woman aged sixty, had had a tumor for about five months in the throat, in the usual situation of abscess of the tonsil. It had attained about the size of a large walnut, exhibited a diffused appearance when viewed through the mouth, and pulsated in a strong and characteristic manner in every portion of its extent. The ligation of the common carotid artery diminished, but did not completely arrest, the throbbing. The woman died in thirty hours after the operation, without any assignable cause. Had a less careful surgeon had the management of this case, he might probably have punctured the tumor under the supposition of its being an abscess, and thus instantly hurled his patient out of existence, much to his own discredit and that of the profession.

Aneurism of *the ophthalmic artery* is rare, both as a traumatic and as a spontaneous affection. The former, caused by various kinds of external injury, is liable to be followed by excessive enlargement of the structures of the orbit with protrusion of the eye. A number of cases of spontaneous aneurism of this artery are upon record, in only a few of which, however, the nature of the disease has been verified by dissection. Aneurism by anastomosis is also sometimes met with. The progress of aneurism of the ophthalmic artery is usually slow, and the symptoms are always characteristic. The proper remedy is ligation of the common carotid artery as early in the disease as possible, before there is any serious structural change in the parts. In anastomotic aneurism, a cure has occasionally been effected with injections with perchloride of iron; and lately several cases have been successfully treated by digital compression of the carotid. For further information on pulsating tumors of the orbit, the reader is referred to the affections of the orbit in the second volume of this work.

Of aneurism of the *supraorbital artery* only a few cases have been recorded. It is always produced by a wound or rupture of the vessel, and is readily recognized by its history, by the rounded or ovoidal shape of the tumor, and by the concomitant thrill and pulsation. The proper remedy is incision of the sac, with ligation of the artery. In an instance observed by Raoult Deslongchamps, a cure was promptly effected by an injection of perchloride of iron.

In the Transactions of the Academy of Medicine of Leipsic, mention is made of a case of aneurism of the *frontal artery*, and three other examples have been recorded, respectively, by Velpeau, Brodie, and Godichon. In the one observed by the latter, the tumor was of a pedunculated form, and larger than an ordinary thumb.

De Haen is said to have met with an aneurism in the dorsal artery of the nose; but it is questionable whether the lesion was anything more than an inordinate dilatation of that vessel.

Anterio-venous aneurism of the extracranial portion of the internal carotid artery is extremely rare. Instructive cases of it have been reported by Bérard, Desparanches, Joret, and Giraldès, all caused by external injury. One instance has been observed in which it was occasioned by a wound inflicted in opening an abscess. In two of the cases here referred to, the carotid artery, as was shown by the dissection, communicated with the internal jugular vein, and a well-marked aneurismal pouch existed between the two vessels. The injury was produced in two cases by a ball, in one by a particle of lead, and in the fourth by a shoemaker's knife. In the case of Giraldès the projectile was found in the aneurismal sac. The symptoms and treatment are the same as in arterio-venous aneurism of the common carotid.

INTRACRANIAL ANEURISM.

Intracranial aneurism possesses little interest in a surgical point of view. Of 85 cases, analyzed, in 1869, by Dr. James H. Hutchinson, of this city, nine occurred under twenty years of age, twelve between twenty and thirty, thirteen between thirty and forty, fourteen between forty and fifty, nineteen between fifty and sixty, eight between sixty and seventy, nine between seventy and eighty, and one between eighty and ninety. Of the 85 cases, 48 were males and 32 were females, the sex in five not being given. The basilar artery was the seat of the aneurism in 25 cases, the middle cerebral in 26, the internal carotid in 10, and in the remaining cases the smaller vessels. From an examination of 142 cases, Professor Bartholow, in 1872, found that the basilar was affected in 40, the middle cerebral in 41, and the internal carotid in 23. The disease may be the result of external injury, as a blow or fall on the head, or of syphilis, but more generally it arises

without any assignable cause. The aneurism, which is not always distinctly sacculated, is usually confined to one artery, and ranges in volume from that of a pea up to that of a pullet's egg. The vessels of the brain seldom exhibit any evidence of disease; but as the aneurism advances, the cerebral substance is displaced and disorganized, one of the most frequent lesions being softening. The cranial bones rarely suffer.

The most reliable symptoms are apoplexy and hemiplegia, buzzing noises in the ears, deafness, dizziness, vertigo, epileptiform convulsions, and pain in the head, either circumscribed or diffused, intermittent or continued, increased by motion, and accompanied by peculiar morbid sensations. These symptoms may come on suddenly, without any premonition, or, as is more frequently the case, arise gradually and almost imperceptibly. The diagnosis is always very obscure. In a few instances, the nature of the disease has been detected by a loud, rough, or whizzing noise on one side of the head, heard by the patient, and distinguished by auscultation.

Death may be produced, first, by the sudden rupture of the sac, and the escape of its contents into the surrounding parts; secondly, by long-continued irritation; and, lastly, by disorganization of the cerebral substance. Of these different terminations, the first is by far the most frequent, it having occurred in 49 of the cases collected by Dr. Hutchinson.

Very little can be effected by treatment. When the diagnosis can be satisfactorily determined, the carotid artery should be tied on the affected side, as was done successfully in a case of this disease by Mr. Coe, of Bristol, England, and in one by Mr. Berkeley Hill, of London.

ANEURISM OF THE VERTEBRAL ARTERY.

Aneurism of this artery, both spontaneous and traumatic, is extremely uncommon, a circumstance no doubt due to the deep situation of this vessel and to its freedom from ossification. In two very interesting cases of this disease, described by Ramaglia, of Naples, and South, of London, the diagnosis was so obscure that the true nature of the disease was not detected until after death. In both the common carotid was tied, without, of course, any benefit. In the former, which was an example of traumatic aneurism, situated behind the left ear, the operator, finding that the deligation did not arrest the pulsation, removed the ligature and treated the case upon general principles, death occurring soon after. In the other instance, in which the carotid artery could be distinctly traced over the tumor, this vessel was also tied under the supposition that it was the seat of the swelling. The tumor, however, rapidly increased, and in a fortnight after caused death by bursting into the trachea. Dissection showed that it was an aneurism of the vertebral artery, situated between the transverse processes of the fourth and fifth cervical vertebræ.

Moebus, a German surgeon, has reported a case of aneurism of the vertebral artery, the result of a wound of the neck, in which a cure was effected by compression and the use of ice.

ANEURISM OF THE INTERCOSTAL ARTERIES.

Aneurism of these arteries is exceedingly uncommon; and the few cases of it upon record are interesting rather as showing the errors of diagnosis committed by surgeons, than as facts illustrative of the history of the nature, progress, and termination of the disease. Dr. Schuster, of Lippe-Detmold, met with a case of caries of the fourth rib in which the corresponding intercostal artery was perforated, the blood which had escaped from the vessel being contained in a distinct sac. A case of aneurism of the intercostal artery, consequent upon a fracture of the rib, has been recorded by Dr. Uhde, of Brunswick. Dr. Martini, of Lübeck, opened an aneurism of the sixth intercostal artery, under the impression that it was a sebaceous tumor. It had apparently been caused by a contusion of the chest, and was associated with caries of the corresponding rib. The patient died. There are doubtless other cases of this affection upon record, but these are the only ones I can find. For the references I am indebted to Günther.

ANEURISM OF THE SUBCLAVIAN AND ITS BRANCHES.

Statistics prove that aneurism of the subclavian is nearly as frequent as that of the carotid. In Lisfranc's table the popliteal comes first, then the femoral, next the carotid, and then the subclavian, the latter having suffered in 16 cases out of 179. In the table

of Mr. Crisp, comprising 295 cases of external aneurism, the subclavian was concerned in 23, and the carotid in 25. The disease is more frequent in the right artery than in the left, in men than in women, and in the laboring than in the higher classes. The period of life during which most of the cases occur is between the thirtieth and fiftieth years. The disease may arise spontaneously, as the result of degeneration of the arterial tissues, but most frequently it is caused by external injury.

Mr. Alfred Poland, of London, who some years ago collected all the reported cases of subclavian aneurism, upwards of 120 in number, finds that 85 affected the right artery and 28 the left, only 2 cases involving both sides. Of the cases in which the sex was observed, 100 occurred in men and 11 in women. Of 79 male cases, in which the age is recorded, 24 occurred under forty years, 28 from forty to forty-nine, 17 from fifty to fifty-nine, and 10 over sixty years. The whole extent of the artery, from its origin to the axilla, was involved only in thirteen cases. The size of the aneurism ranged between a pigeon's egg and a child's head : 13 of the cases were traumatic, and 72 were idiopathic, the artery in 33 affording distinct proof of the existence of atheroma.

Although the disease may affect any portion of the artery, it is most frequent beyond the scalene muscles, a short distance before it becomes merged in the axillary. The form of the aneurism is generally globular or ovoidal, but cases are observed in which it has a singularly compressed appearance ; and, on the other hand, it may be remarkably lobulated, especially when it is very capacious, and extends deeply among the surrounding structures, which thus indent its surface. Its volume is seldom very large, unless it becomes diffuse, when it may attain an enormous magnitude, reaching nearly up to the angle of the jaw, pushing out the clavicle, overlapping the trachea, displacing the scapula, pressing backwards against the ribs and spine, and dipping into the cavity of the chest so as to force down the lung and impede respiration.

As the aneurism enlarges, it necessarily encroaches upon and compresses the neighboring parts, causing more or less pain, œdema, difficulty of respiration, dilatation of the veins of the neck, chest, and upper extremity, and a feeling of numbness and sometimes even partial paralysis. Loss of motor power in the corresponding arm and hand, diminution of temperature, contraction of the pupil, and increased action in the carotid artery, are occasional symptoms. The pulse at the wrist is often sensibly diminished, and sometimes totally absent. Originally small, deep-seated, circumscribed, indolent, and movable, the tumor generally steadily augments in volume, approaching, as it does so, nearer and nearer to the surface, loses its defined shape, becomes the seat of incessant pain, and at length contracts firm adhesions to the surrounding structures, identifying itself, as it were, with them. Examined with the ear and hand, it readily imparts to them the peculiar beat, thrill, and bellows sound so characteristic of aneurism in other regions.

Diagnosis.—The diagnosis of subclavian aneurism is sometimes extremely difficult, and several cases have been reported in which the vessel was ligated where no disease of the kind existed. The affections with which it is most liable to be confounded are aneurism of the innominate artery or arch of the aorta, abscesses, and various kinds of tumors, solid and cystic, benign and malignant. As these lesions are of frequent occurrence in this region, it is impossible for the surgeon to be too cautious in his examination of cases involving questions of diagnosis.

The history of the tumor and its situation at the side of the neck, just above the clavicle, generally afford important data in regard to the diagnosis. If the patient is under thirty years of age, it may almost certainly be assumed that the disease is not spontaneous aneurism, as there are probably not three well-authenticated instances on record in which the subclavian was thus affected at this early period. Aneurism of the innominate is situated lower down, and approaches nearer to the middle line, than aneurism of its subclavian division ; and in aneurism of the aorta, the tumor, although it may extend into the neck, rarely projects as far above the clavicle as in the lesion in question ; certainly not in its earlier stages, when alone a correct diagnosis can be of any avail in an operative point of view. If the case is seen soon after its commencement, before the tumor has attained any considerable bulk, a very good idea may often be formed as to the precise portion of the artery that is affected by it. Thus, for example, if the aneurism occupies the space immediately exterior to the sterno-cleido-mastoid muscle, and manifests a tendency to extend upwards into the neck, and downwards in the direction of the axilla, it may be assumed that it is seated upon the outer portion of the vessel beyond the scalene muscles. On the other hand, it may be concluded that it is connected with the inner portion of the artery if the tumor is placed under cover of the sterno-mastoid muscle, and is gradually making its way over towards the middle line, thus leaving the inferior triangle of the neck clear. It

may be added that in subclavian aneurism the tumor is less liable to encroach upon the windpipe and œsophagus than in innominatal and aortic aneurism, and hence there is generally much less cough, dyspnœa, and dysphagia in this than in the other affections. It is only, in fact, when the tumor is of great bulk, or when it happens, from the peculiarity of its position, to exert much pressure upon the pneumogastric, phrenic, and laryngeal nerves, that any serious symptoms of this kind will be likely to arise.

Progress.—Subclavian aneurism is always a serious disease, a spontaneous cure, although possible, as several cases upon record testify, being an extremely rare occurrence. In general, the disease progresses until it attains a certain point of development, when it terminates fatally, either by ulceration and hemorrhage, or by the induction of constitutional irritation. The sac may open externally, a not uncommon event, especially when it is invaded by gangrene; or it may burst into the pleura, lungs, trachea, or œsophagus; in either case, death takes place, either instantly or within a short time after the tumor has begun to give way. There are several cases on record in which the aneurism pointed in the axilla and on the shoulder, having completely eroded some of the upper ribs and the body of the scapula, the latter being scooped out so as to form a kind of bed for the accommodation of the sac.

Of 35 cases tabulated by Poland, in which no mechanical or surgical interference was adopted, 11 recovered, 23 died, and 1 was relieved. In 22 of these cases, 4 underwent a spontaneous cure, without any treatment whatever, while of the remaining 13, in which the patient was either bled or some internal remedy administered, 7 were cured, 5 died, and 1 was benefited.

Treatment.—The treatment of subclavian aneurism has hitherto been exceedingly unsatisfactory, and there is no probability, judging from the deep situation and intricate relations of the tumor, that much benefit will ever accrue from any mode of management that may be devised for its relief. Acupuncturation and electricity, from which so much benefit had at one time been anticipated, have likewise disappointed expectation. Some time ago a case was reported in which a cure was alleged to have been effected by galvanopuncture, but the example is a solitary one, and the procedure is of too problematical a character to merit serious attention. The measures which have hitherto proved to be the most promising are the plan of Valsalva, direct compression of the sac, and manipulation. In the event of the failure of these methods of treatment, of what resource can the surgeon avail himself in this unfortunate class of cases? Ligation of the affected artery is not only difficult, under any circumstances, from the position of the tumor and the intricacy of its anatomical relations, but is frequently absolutely impracticable on account of the diseased state of the artery, rendering it unable to support the ligature. Shall he adopt the operation of Dr. Mott, and secure the innominate, of which the subclavian, on the right side, is one of the main divisions? Here, again, obstacles meet him in every direction, for even if he should be so fortunate as to get his ligature around the vessel, which, however, is by no means always the case, he will find, by consulting the history of the operation, that every instance, with one exception, in which it has been performed has had a fatal termination. Nothing, therefore, is to be gained from this procedure. In short, the Hunterian principle of operation is hardly applicable to any case of subclavian aneurism. On the right side, we are not only obliged to encounter, as just stated, great difficulties in reaching the innominate artery, but in throwing a ligature around the vessel we effectually cut off a large and important supply of blood from the brain, thus greatly enhancing the dangers of the case.

The innominate artery has been tied for the cure of aneurism of the subclavian in 14 cases, and in 2 for hemorrhage. The results are subjoined in tabular form.

Ligation of the Innominate Artery.

No.	Operator.	Date.	Age	Sex	Disease.	Result.	Remarks.
1	Mott	1818	57	M.	Subclavian aneurism	Died on 26th day	Artery tied half an inch below its bifurcation; ligature separated on the 14th day; hemorrhage on the 9th, and again on the 23d day; death on 26th day. Ulceration of the artery, and want of occlusion.
2	Graefe	1822	...	M.	Subclavian aneurism	Died on 67th day	Ligature came off on the 14th day; death from hemorrhage.
3	Norman	1824	...	M.	......	Died	Death from pericarditis in sixty hours.
4	Arendt	1824	36	M.	Subclavian aneurism	Died on 8th day	Cause of death inflammation of the aneurismal sac and of the pleura and lung.

No.	Operator.	Date.	Age	Sex	Disease.	Result.	Remarks.
5	Hall	1830	45	M.	Subclavian aneurism	Died on 5th day	Artery morbidly adherent, dilated, soft, and friable ; torn in the attempt to separate it, at two points, between which the ligature was applied ; copious hemorrhage during operation ; plugging of the wound ; participation of the aorta and carotid in the disease.
6	Bland	1832	31	M.	Subclavian aneurism	Died on 18th day	Ligature placed around the artery near its bifurcation ; hemorrhage on the 17th day, proving fatal on the 18th ; the innominate and carotid closed by solid clots ; the subclavian still open.
7	Lizars	1837	30	M.	Subclavian aneurism	Died on 21st day	Ligature separated on the 17th day ; pleuritis ; death caused by repeated hemorrhages ; twenty ounces of coagulated blood at the root of the neck ; arteries imperfectly closed.
8	Hutin	1842	26	M.	Hemorrhage after ligature of subclavian	Died in 12 hours	Tied for secondary hemorrhage, after subclavian had been secured for wound of the axillary.
9	Gore	1856	52	M.	Subclavian and axillary aneurism	Died on 17th day	Death from hemorrhage ; aneurism contracted and filled with coagulum. Artery cut through by ligature. Pus in subclavian vein and anterior mediastinum.
10	Cooper	1859	...	M.	Subclavian and carotid aneurism	Died on 9th day	Upper end of sternum and clavicle removed to facilitate operation ; dyspnœa and retention of urine ; pus in right kidney ; death probably from uræmia and pyæmia.
11	Cooper	1869	31	M.	Subclavian aneurism	Died on 41st day	Ligature, applied an inch from the aorta, detached on the 18th day ; patient did well for three weeks, when hemorrhage occurred, and finally caused death. Upper end of sternum and clavicle removed.
12	Pirogoff	1864	46	M.	Subclavian aneurism	Died in 24 hours	Cause of death œdematous suppuration of sheath of artery, extending to the mediastinum and pericardium.
13	A. W. Smyth	1864	...	M.	Subclavian aneurism	Recovery	Ligature applied to innominate a quarter of an inch below point of division, and at the same time to carotid one inch above origin. Hemorrhage on 15th day, controlled by plugging wound with small shot and ligature pulled away. Hemorrhage recurred on 33d and 51st days, and vertebral artery tied on 54th day. Patient died at end of ten years of the original aneurism, which again formed by the reverse collateral circulation.
14	Lynch	1867	23	M.	Hemorrhage from gunshot wound of internal carotid and vertebral arteries	Death	Common carotid ligated one month previously. Death from hemorrhage on 12th day, when the ligature was found lying loose in wound. Partially organized clots in cardiac end of artery. Close to point of ligation an anomalous branch was given off, which, by keeping up the circulation on the cardiac side of ligature, permitted the clot to be loosened on its separation.
15	A. B. Mott	1868	...	M.	Subclavian aneurism	Died on 23d day of hemorrhage in thorax.	Carotid was tied at same time ; sac burst into pleural cavity.
16	Bickersteth	1868	40	M.	Subclavian aneurism	Death on 6th day from hemorrhage	Artery was first secured by lead wire, which was replaced on second day by two ligatures, one above and the other below the wire. Clot firm in innominate on cardiac side ; subclavian occluded ; carotid open, and hence seat of fatal hemorrhage.

All the cases in the above table, except six, proved fatal from hemorrhage of the wound, caused by the want of occlusion either of the ligated artery, or of the carotid and subclavian. It will be observed that Graefe's patient survived upwards of two months. I purposely exclude from the table the cases which are usually referred to as having occurred in the practice of Dupuytren and Bujalski, not considering them as sufficiently well authenticated to entitle them to a place in it. I also reject from it several reported cases in which the operation of ligating the innominate artery was commenced but not completed.

Dr. Peixotto, of Portugal, in 1851, surrounded the innominate artery with a ligature, on account of secondary hemorrhage from the common carotid, which had been ligated three weeks previously. The ligature, however, which was a precautionary one, was not tightened, but applied merely so as to flatten the vessel. The patient made a good recovery. Such an operation can hardly be regarded as a true case of deligation of the innominate artery. The cure was doubtless effected by the ligation of the other vessel.

Mr. Key, of London, in a case of aneurism of the subclavian, found it impracticable to apply a ligature to the innominate, in consequence of the volume of the tumor, and the diseased condition of the latter vessel. The patient was seized soon after the operation with symptoms of pulmonary distress and exhaustion, and died on the twenty-third day.

The operation of ligating the innominate artery is one of no inconsiderable difficulty even in the dead subject, but in the living the perplexity is greatly increased by the proximity of the aneurism, by the presence of glandular swellings, and, above all, by the manner in which the parts at the root of the neck are matted together by plastic deposits, rendering it thus exceedingly troublesome to separate them. These embarrassments were experienced in a striking degree by Dr. Hall, of Baltimore; he had great difficulty in isolating the vessel, and, in attempting to do so, tore it at two points, ligating it afterwards between them. Hemorrhage occurred at the time, but was checked by plugging the wound. Another obstacle to successful deligation is disease of the vessel, consisting either in a morbid dilatation, or in a softened and lacerable condition of its coats. Unforeseen difficulties were present in more than one-fourth of the cases in which ligation of the artery has been attempted, compelling the operators to desist, notwithstanding their great dexterity and profound knowledge of the anatomy of the neck.

Mr. Porter, of Dublin, in 1831, attempted to tie this artery on account of aneurism, but was obliged to desist on account of its diseased condition. The tumor, nevertheless, gradually disappeared, and the patient, a man forty-seven years of age, finally recovered.

Dr. Hoffman, of New York, in a case of subclavian aneurism in a man sixty-three years of age, cut down upon the innominate artery with the design of applying a ligature to it, should he be unable to ligate the subclavian; but, as the vessel was found to be much enlarged, it was deemed inexpedient to proceed any further. The operation was performed in October, 1839, and death occurred in January, 1840.

The proposal to ligate the innominate artery originated with Allan Burns, from a conviction that the circulation in the head and upper extremity could be maintained without the agency of this vessel, and that it could be easily enough exposed by tracing it downwards towards the aorta, by a careful and patient dissection, the head being at the time bent well back. It remained, however, for Dr. Mott, in 1818, to put the suggestion to the test of experiment upon the living subject; and, although the operation had an unfavorable issue, the man dying, as has already been stated, on the twenty-sixth day, we cannot but admire the genius which could plan, and the intrepid skill which could execute, so daring and brilliant a feat. The case was one of subclavian aneurism above the clavicle, and the design had been to apply the thread to the latter vessel, but, after exposing it on the tracheal side of the scalene muscle, it was found that its tunics were too much diseased to bear the pressure of the ligature, and he accordingly tied the innominate in its stead.

It will thus be seen that the only successful case of ligation of this vessel, is that of Dr. Smyth, who tied both the innominate and the carotid at the same time, and the vertebral fifty-four days after, an expedient which alone saved the patient's life. Alexander B. Mott also tied the innominate and carotid simultaneously, but the man died on the twenty-third day, from the rupture of the aneurism into the pleural cavity. All the cases recorded in the table were males, most of them under forty years of age. In fourteen out of the sixteen the operation was performed for the relief of subclavian aneurism. In the cases of Lizars and Valentine Mott, an anomalous branch, probably the middle thyroid, arose from the innominate near the ligature and probably interfered with the success of the operation. Dr. John A. Wyeth, in referring to this vessel, states that he met with it five times in thirty-four consecutive dissections.

LIGATION OF THE SUBCLAVIAN ARTERY ON ITS TRACHEAL ASPECT.

This vessel is sometimes ligated in the first portion of its course for aneurism between or beyond the scalene muscles. The subjoined table, comprising eleven cases, will serve to place the subject in its true light.

No.	Operator.	Sex.	Age.	Result.	Remarks.
1	Colles	M.	33	Death	In this case there was only a space of three lines between the sac and the bifurcation of the innominate. The patient died of hemorrhage on the fourth day.
2	Mott	F.	21	Death	The patient died on the eighteenth day, of hemorrhage.
3	Hayden	F.	57	Death	Death on the twelfth day, from hemorrhage.
4	O'Reilly	M.	39	Death	The patient died on the thirteenth day, of hemorrhage.
5	Partridge	M.	38	Death	Fatal on the fourth day, from pericarditis and pleurisy.
6	Liston	M.	32	Death	The patient died on the thirty-sixth day, of hemorrhage.
7	Auvert	...	...	Death	Fatal hemorrhage on the twenty-second day.
8	Auvert	...	...	Death	Fatal hemorrhage on the eleventh day.
9	J. K. Rodgers	M.	42	Death	Fatal hemorrhage on the fifteenth day.
10	Arendt	M.	...	Death	Death from exhaustion on fifth day; no hemorrhage.
11	Bayer	M.	21	Death	Fatal hemorrhage in twenty-four hours.

The result in all the above cases, except two, was death by hemorrhage, notwithstanding the undoubted ability and skill of the operators, comprising some of the most illustrious names in surgery. Should this fact not be sufficient to deter practitioners from repeating the operation, or should they continue in their efforts to save life until some one, more fortunate than the rest, shall succeed in finding an exceptional case? The case of Dr. J. Kearney Rodgers, of New York, in which the artery was secured on the left side on account of an aneurism, is of the deepest interest in this respect, as showing that, although the patient finally perished from hemorrhage, yet the ligated vessel was completely closed by an adherent coagulum. The cases of Cuvellier and Parker, and one of Liston are excluded from the table, since they were examples of simultaneous ligation of the carotid and subclavian arteries; as are also those of Ayres and Bullen in which the subclavian was tied for shot wounds, and the case of Kuhl in which the carotid and subclavian arteries were ligated for a vascular tumor of the frontal region.

Until the operation of Dr. Rodgers, it was universally regarded as impracticable to ligate the left subclavian artery on the inside of the scalene muscles, such being the intimate relation of the vessel in this situation to the sac of the pleura, the carotid artery, internal jugular vein, pneumogastric nerve, and thoracic duct. It had been thought that, from the severe injury which would necessarily be inflicted upon the surrounding structures during the operation, violent and fatal inflammation must be the speedy and inevitable consequence. At all events, no one had yet been found ingenious enough to devise, and bold enough to execute, such an enterprise. Although it is not likely that the operation will soon be repeated, the case in question deserves notice here as a matter of surgical history, if nothing more.

The patient was a man, aged forty-two, who, in lifting a heavy weight, upwards of a month previously, was suddenly seized with an aneurism of the left subclavian artery. At the time of his admission into the New York Hospital, the tumor could be seen above the clavicle, about the size of a small hen's egg, extending outwards towards the shoulder, and inwards towards the sterno-cleido-mastoid muscle, by the outer border of which it was considerably overlapped. The operation was performed on the 14th of October, 1845. Two incisions were made; one, three inches and a half in length, along the inner border of the sterno-mastoid muscle, terminating at the sternum, and dividing the integument and platysma-myoid muscle; the other, two inches and a half in length, extending horizontally over the inner extremity of the clavicle, the two meeting at a right angle near the trachea. Several small veins having been ligated, and the flap thus formed dissected up, the sternal portion with half of the clavicular of the mastoid muscle was divided upon a grooved director, a procedure which fully brought into view the sterno-hyoid and omohyoid muscles and the deep-seated jugular vein, all covered by the cervical fascia. A part of the aneurismal sac was also in sight, overlapping a considerable portion of the anterior surface of the scalene muscle, upon which the operator could distinctly feel the phrenic nerve. By digging with the handle of the knife and fingers, the deep cervical fascia was now divided close to the inner edge of the scalene muscle,

when, after a little search, the subclavian artery was easily discovered as it passed over the first rib, pressure upon this portion readily arresting the pulsation of the tumor. The next step of the operation consisted in passing the ligature around the vessel without injury to the pleura and thoracic duct, but this proved to be one of extreme difficulty, owing to the great narrowness and depth of the wound, the latter nearly equalling the length of the forefinger. This, however, was at length successfully accomplished by means of an aneurismal needle with a movable point, carried from below upwards. The moment the ligature was tied all pulsation in the tumor ceased, and the patient, if not entirely comfortable, made no complaint of any kind.

The wound became somewhat erysipelatous after the operation, but, on the whole, the patient got on well until the 26th of October, when, on changing his position in bed, hemorrhage supervened, and, continuing to recur at various intervals, destroyed him on the fifteenth day. On dissection, the wound was found to be filled with clotted blood, beneath which the artery had been completely divided by the ligature, which lay loose close by. The stump of the subclavian, between the aorta and the point of ligation, was about an inch and a quarter in length, and thoroughly impervious to air and liquids, its caliber being occupied by a solid and firmly adherent coagulum. The distal extremity of the subclavian contained a soft, imperfect clot, while the vertebral artery, which was given off immediately at the site of the ligature, was almost patulous, and had evidently been the seat of the hemorrhage which caused the patient's death. The aneurismal sac, the size of a small orange, was completely blocked up with coagula. The thoracic duct was uninjured, but the pleura at the bottom of the wound was found to be extensively lacerated, and through the opening thus formed a large quantity of blood had passed into the left cavity of the chest.

In reflecting upon this interesting case, Dr. Rodgers regretted that he had not secured the vertebral artery and also the thyroid axis, believing that this would have effectually prevented the fatal hemorrhage. Professor Willard Parker, acting upon this suggestion, in September, 1863, tied the left subclavian artery on the inside of the scalene muscles, along with the common carotid and vertebral, on account of subclavian aneurism. The case progressed well until the tenth day, when there was a slight hemorrhage. The ligature separated from the vertebral on the twelfth day, from the carotid on the fourteenth, and from the subclavian on the twenty-fourth. Death occurred at the end of the sixth week, from hemorrhage of the distal side of the subclavian.

In examining the tables of Dr. Wyeth, I find that ligation of the second or third portion of the subclavian artery has been practised for the cure of aneurism of that vessel 38 times, with 18 recoveries and 20 deaths. Of the cures, seventeen were examples of subclavio-axillary vessel, while one was an example of pure subclavian aneurism. In two instances partial division of the scalene muscle was required to give more room for the operation. The average period at which the ligature separated, according to Mr. Poland, who has recorded twenty-one cases, was 32 days, the minimum 15, and the maximum 96. The latter was the remarkable case of Dr. J. M. Warren, in which the subclavian artery was successfully tied on the outside of the scalene muscles for an aneurism of this vessel situated above the clavicle.

All of the 20 fatal cases were subclavio-axillary aneurisms except one, and in one partial division of the scalene muscle was necessary. Nine deaths were due to hemorrhage, two to coma, four to exhaustion, and three to lung complications, the cause being unknown in two.

Aneurism of the subclavian has also been treated by the distal ligature, but with the most unpromising results. Thus, ligature of the carotid proved fatal on the fourth day in the hands of Mr. Butcher, while ligation of the axillary, performed by Dupuytren, Schuh, and Canton, was equally unsuccessful. In a case of aneurism of the first part of the subclavian, Pétrequin also tied the axillary artery. The tumor continuing to pulsate, the sac was punctured, and eight or nine drops of a solution of perchloride of iron were thrown in, the brachio-cephalic trunk being compressed during the injection and for ten minutes afterwards. The next day all pulsation had ceased in the tumor, but the patient died of hemorrhage at the place of ligature twelve days after its application. In 1874 Dr. Toland, of San Francisco, ligated the third portion of the subclavian artery with two threads for an aneurism as large as the fist. The ligatures came away on the twentieth day, and neither pulsation nor bruit could be detected in the tumor at the end of six weeks.

In 1838, Mr. Liston secured the common carotid and the first portion of the subclavian, in a tailor, thirty-one years of age, in whom galvano-puncture had been unsuccessfully

employed. Death resulted from hemorrhage on the thirteenth day. In a case of traumatic subclavian aneurism, from a bayonet-thrust at the battle of Magenta, in a dragoon, aged twenty-one years, Cuvellier performed a similar operation, followed by hemorrhage on the tenth day.

It thus appears that the treatment of subclavian aneurism by the ligature is most unsatisfactory. Of 72 cases, 52, or 72.22 per cent., proved fatal, the only successful issues having been obtained in one case out of fourteen of ligation of the innominate, in two cases out of five of ligation of the second portion of the subclavian, in sixteen cases out of thirty-three of ligation of the third portion of the subclavian, and in one case out of six of distal ligation. Under these circumstances it is questionable whether ligature of the innominate, or of the first portion of the subclavian should be repeated. As pointed out by Wyeth ligation of the second portion of the left subclavian is as safe as that of the third division, so that it may be tied when the necessity exists.

Mr. George H. Porter, of Dublin, in 1867, treated unsuccessfully a case of aneurism of the right subclavian artery by acupressure of the axillary artery, followed, at the end of about five weeks, by direct pressure of the innominate artery, death occurring ten days after the latter operation, from secondary hemorrhage caused by slight gangrene of the vessel at the site of the compression.

Benefit may occasionally arise in subclavian aneurism from *manipulation* of the tumor, as practised by Fergusson; some of the clots detached in the operation may accidentally find their way into the distal extremity of the vessel, and thus occlude its caliber along with the interior of the aneurismal sac. In a disease so desperate as this, in which every expedient hitherto devised has been tried in vain, any suggestion that holds out the least possible chance of relief is worthy of trial. Of seven cases that were subjected to this mode of treatment, three died, one was unsuccessful, and three recovered, the latter having been reported by Fergusson, Little, and Pemberton.

Compression, whether digital or mechanical, proximal or distal, of the artery leading to or from the sac, has been attempted in several instances, but, from the difficulty of applying and maintaining pressure, it has, with three exceptions, been uniformly attended with failure. Mr. Poland has narrated a case of subclavian aneurism, of the size of a filbert, occurring in a man, forty-four years of age, cured by digital compression of the artery on the cardiac side of the tumor, the thumb having been placed over the vessel at the outer border of the scalene muscle. It was kept up for ninety-six hours, with a few minutes' intermission, when the tumor was much harder and smaller, although it still pulsated slightly. At the expiration of a week the pulsation had ceased, and the tumor subsequently entirely disappeared. The course of the artery was high above the clavicle, having, probably, been lifted up by a cervical rib, which thus afforded a good point for counterpressure. Digital compression, combined with the subcutaneous injection of ergotine, proved successful in the hands of Dutoit; but Mr. Willett lost his patient from rupture of the sac, which had at the same time been subjected to direct compression. Dr. Warren Stone applied compression with the finger on the distal side of the sac for thirty-nine hours; but the pulsation did not cease entirely until the expiration of nine months. In several cases the measure had to be abandoned in consequence of the severe suffering to which it gave rise.

Moderate direct compression of the sac has been successfully employed in four instances, collected by Mr. Poland, and is worthy of more extended trial. In two cases in the hands of Dr. J. M. Warren, too far advanced for ligation, a cure was effected by direct compression, aided by the application of bags of ice. The tumor, in one of the cases, suppurated and partially discharged its contents. In a fifth case death ensued.

Galvano-puncture has effected one cure in five cases, but this mode of treatment is too dangerous to deserve imitation.

Injection of the sac with coagulating fluids has been practised at least three times. In the case of Dr. Mott, immediate death ensued. The case of Petréquin, above referred to, was a failure, while the third case terminated fatally from hemorrhage.

The introduction of horsehair, to which Dr. Levis resorted in 1873, was followed by death on the thirty-fourth day.

Finally, amputation of the arm at the shoulder-joint, with distal ligation of the axillary artery on the face of the stump, may be resorted to, as originally suggested by Fergusson, and successfully practised by Spence, in 1864. The patient, an engineer, thirty-three years of age, left the hospital on the forty-fourth day in excellent health, but four years subsequently death ensued from supposed internal aneurism. In three other cases, in the hands, respectively, of Mr. Heath, Mr. Holden, and Mr. Smith, the measure failed; but

in the case of Mr. Rose, in which the common carotid artery was also ligated, the tumor, at the end of three weeks, was reduced one-third, and the patient was free from suffering.

Arterio-venous aneurism of the subclavian artery is extremely uncommon. Sanson met with an example, the result of a bullet wound, and Baron Larrey has recorded two cases, produced, respectively, by a sabre-thrust and gunshot injury. In none of these cases did the tumor give rise to serious inconvenience. In an instance of this kind under my own observation during the last six years, the only annoyance experienced is from the noise of the tumor.

ANEURISM OF THE TRANSVERSE CERVICAL ARTERY.

A case of aneurism of this artery, the only one of which I have any knowledge, was reported, in 1869, by Mr. Pick, in the Transactions of the Pathological Society of London. The tumor, situated on the left side of the neck, just above the clavicular origin of the sterno-mastoid muscle, was of the size of a walnut, soft and fluctuating, with forcible pulsation, and a peculiar upheaving of the entire mass as if the sac lay merely over an artery instead of forming a component part of it. There was scarcely any audible bruit. The tumor took its rise close to the origin of the transverse cervical artery, which in this instance came off directly from the subclavian, and not, as is usually the case, from the thyroid axis. It rested upon the subclavian vessels, was partially covered by the clavicular attachment of the sterno-mastoid muscle, and was completely filled with a firm, semitransparent clot, intimately adherent to the walls of the sac, but without any laminated arrangement. All the coats of the artery seemed to have been involved in the aneurism, the communication between them having been established by a small orifice. The patient was a soldier, forty-five years of age, recently discharged from the army, and the tumor had been noticed for the first time only three weeks before death, which was caused by phthisis. Direct pressure with a pad and bandage was kept up for some time, after which iodine was daily applied with marked advantage, although the pulsation and the upheaving appearance continued to the last. The diagnosis was obscure.

ANEURISM OF THE SUBSCAPULAR ARTERY.

Of spontaneous aneurism of this vessel I do not find a solitary instance upon record; a circumstance easily accounted for, by the deep situation of this vessel, its small size, and the infrequency of the degeneration of its tunics. Of the traumatic form of the lesion a case was reported in 1874, by Dr. Monmonier, of Baltimore, in a man twenty-one years of age, who, sometime previously, had fallen down a flight of stairs, the arm being thrown suddenly upwards and violently extended so as to rupture the vessel. The tumor, which was of considerable size, occupied the left axilla, was of a firm, fibroid consistence, and destitute of pulsation. Fearing that the hemorrhage might prove troublesome, Dr. Monmonier tied the subclavian artery in the third part of its course, and then laid open the tumor and turned out the clots. Recovery occurred without any accident.

ANEURISM OF THE AXILLARY ARTERY.

Aneurism of the axillary artery is less frequent than that of the subclavian. In 364 preparations of aneurism in the London museums, examined by Mr. Crisp, including 249 of the aorta, the axillary artery was affected only in 8. In 551 cases analyzed by him from different sources, including 234 cases of aneurism of the aorta, 18 only were of the axillary artery.

The disease is most frequent in men, between the ages of thirty-five and fifty. It is very often of traumatic origin. In an instance recorded by Roux it was caused by the pressure of an exostosis. The volume of the tumor ranges from an egg to that of a child's head, the average being that of a fist. Arterio-venous aneurism of the axillary vessels is very uncommon.

Symptoms.—The symptoms of axillary aneurism are generally so well marked as to render it impossible to mistake their character. When the disease arises spontaneously, or without any assignable cause, it may exist for several months without attracting any particular notice, and the same thing occasionally occurs when it results from external violence, as a blow or strain. Generally, however, the tumor rapidly augments in bulk,

and produces such a train of phenomena as to lead at once to its detection. Of these, one of the earliest, and at the same time most unpleasant, is the sense of fatigue or uneasiness in the affected part arising from the pressure on the axillary plexus of nerves. This symptom is usually succeeded in a few weeks, sometimes, indeed, in a few days, by a feeling of pain, which is always in direct ratio to the size of the aneurism, being comparatively slight when it is small, and more or less intense when large. Nor is the pain confined to the site of the disease; in most cases it radiates from it, as from a common centre, in different directions, outwards into the shoulder, downwards along the arm, and upwards into the neck. Pressure, severe coughing, the recumbent posture, and the weight of the limb, greatly increase it. Numbness of the shoulder, chest, and arm, is another symptom which generally manifests itself at an early period of the disease, and is never absent when the tumor has acquired considerable magnitude. It is always very distressing to the patient, is greatly aggravated by pressure on the swelling, and commonly extends to the ends of the fingers. Indeed, it is here that the sensation in question is often most keenly felt.

The pulsation of the tumor, at first faint and scarcely perceptible, becomes very distinct during the progress of the disease, so that it cannot only be felt by the fingers, but seen at a considerable distance; sometimes, indeed, ten or twelve feet from the patient. On applying the ear or the stethoscope to the tumor, the blood is found to rush into it with more or less violence, producing a peculiar thrill, or whizzing noise, synchronous with the contraction of the left ventricle of the heart. In the early stage of the disease, the swelling is soft and elastic, and may readily be emptied by pressure; by degrees, however, it becomes firm, tense, and, in great measure, if not entirely, incompressible. In some cases, especially in those attended with great enlargement, there is considerable diminution of the temperature of the affected limb, with indistinctness, if not entire absence, of the pulse at the wrist, more or less cough, dyspnœa, and shortness of breathing. Occasionally the pulse is fully as strong as in the other arm, but irregular or intermittent, losing several strokes in a minute.

In addition to these symptoms, there is always, when the swelling is large, so much displacement of the clavicle as to render it difficult, if not impossible, to distinguish the pulsation of the subclavian artery, the vessel being deeply buried behind and below the bone. In some instances the collar-bone has been found to be considerably imbedded in the tumor, or partially removed by absorption. Another symptom, which, from its frequency, especially in the latter stages of the disease, requires mention here, is the swelling of the affected limb. This varies in degree in different cases, often extends from the shoulder to the ends of the fingers, and is usually of an œdematous character, pitting under pressure, and becoming aggravated by the dependent position of the part. When thus affected, the muscles lose their contractile power, and the motions of the extremity are proportionately impaired, or entirely annihilated. Sometimes, again, owing to the great magnitude of the tumor, the patient is unable to approximate the limb to the side of the chest. Finally, there is another phenomenon, which, as it is almost invariably present in the latter stages of axillary aneurism, I am disposed to regard as pathognomonic. I allude to the peculiar attitude of the patient, arising from the constant inclination of the head towards the affected side, and the manner in which he supports the corresponding arm; the object of both being evidently to prevent the tension which would otherwise be caused in the tumor. Under these circumstances, too, the countenance wears an anxious and distressed appearance, and, as the system always deeply sympathizes with the local affection, there is more or less derangement of the general health.

When the tumor is unusually bulky, it will necessarily greatly encroach upon the clavicle, forcing it upwards into the neck, and at the same time exerting severe pressure upon the subclavian artery, perhaps so much as to render it difficult, if not impossible, to distinguish the pulse at the wrist.

Diagnosis.—Notwithstanding that the symptoms of this disease are usually well marked, sometimes tumors of this description have been opened, under the belief that they were abscesses. For such an error no apology can be offered. Still, cases occasionally present themselves, although very rarely, in which it is extremely difficult, at first sight, to distinguish between this and other swellings in the armpit or subclavicular region. Enlarged lymphatic glands, adipose tumors, or sarcomatous growths, for example, if they chance to lie along the course of the axillary artery, might have its pulsation imparted to them, and thus create some doubt in regard to their real character. Under such circumstances, the facility with which the mass can be elevated or removed from the vessel, the absence of the peculiar whizzing sound, previously alluded to, as being generally present in aneu-

rismal disease, the slight pain and numbness in the part and in the corresponding limb, the continuance of the swelling on the application of pressure to the subclavian artery, and, above all, the history of the case, will generally be sufficient to establish the diagnosis.

In this disease the tumor may be situated either immediately below the clavicle, or in the axilla, properly so called. In the former case, it may not only elevate the clavicle, but extend up into the neck, beneath the bone, as far as the outer border of the scalene muscles. In the latter, it has been known to reach some distance down the arm, so as to compress the brachial artery and nerves, and prevent the approximation of the limb to the side.

Prognosis.—Axillary aneurism occasionally undergoes spontaneous cure, as in the instances reported by S. Cooper and Breschet. Such an occurrence, however, is extremely uncommon. Most generally, the disease, if left to itself, terminates fatally, either by rupture of the sac and exhausting hemorrhage, or by gangrene of the limb. Sometimes, although rarely, the tumor destroys life by inducing caries of the ribs and perforation of the pleura, followed by an escape of its contents into the cavity of the chest. In a case narrated by Mr. Guthrie, it was ascertained, on dissection, that the aneurism had forced its way into the right side of the chest by the destruction of a portion of the first five ribs, and had contracted adhesions to the upper lobe of the lung, into which it had gradually opened and discharged its contents, the man having spat blood more or less profusely for several weeks prior to his death. In a similar case mentioned by Dr. Neret, of Nancy, an aneurism, about the size of a large chestnut, communicated with a cavity of the volume of the head of a new-born infant in the upper part of the left lung. The man had been admitted into the hospital on account of hemoptysis.

Treatment.—Intermittent digital compression of the subclavian artery, as it passes over the first rib, should always be resorted to for this disease before recourse is had to the ligature, as it holds out considerable prospect of permanent relief. Thus, of 9 cases in which it was practised, 6 were cured. In one the compression was applied under chloroform, once for three hours and a quarter, and on another occasion for eight hours. In a second case it was maintained for six hours a day for six days. In two other successful examples, on the other hand, it was applied at intervals, respectively, for three months and six months. In the event of the failure of the measure, the only remedy is ligation of the subclavian artery, and the sooner this is done, the more likely will it be to succeed. The operation, however, should not be declined, even although gangrene of the sac has already commenced, provided there is nothing else to forbid it.

Mr. Syme laid open, with complete success, a spontaneous aneurism in this region, turning out its contents, and tying the axillary artery above and below the points of communication with the sac. As a means of safety, the subclavian was compressed by the finger of an assistant against the first rib, through an incision in the neck which divided the skin and fascia. By this procedure the circulation was so effectually controlled that there was hardly any hemorrhage. Few operators, unless possessed of the most consummate skill, would be willing to imitate the example of the Edinburgh surgeon, or not prefer the ligation of the subclavian artery on the outside of the scalene muscle.

In a case of axillary aneurism, the size of a child's head, the result of a gunshot injury received six years previously, under the care of Dr. C. C. F. Gay, of Buffalo, the tumor, previously pierced by a large trocar at the softest part, burst under the pressure of the fingers during the examination, followed by profuse hemorrhage. This was, however, speedily controlled by thrusting the hand through the rent, behind the clots, and seizing the axillary vessels. The subclavian artery was then compressed, and next tied at the junction of its second and third portions. On the ninth day secondary hemorrhage supervened, but was promptly arrested by plugging the wound with lint wet with Monsel's salt. The ligature came away on the seventeenth day after the operation, and in six weeks the patient was well, with the exception of slight paralysis of the arm.

Mortality.—Of 27 cases of axillary aneurism, which I analyzed in 1841 in the Western Journal of Medicine and Surgery, including one of my own, for which the subclavian artery had been tied, 17 recovered and 10 died, death occurring from the third to the thirtieth day, either from hemorrhage, gangrene of the arm, ulceration of the artery, pericarditis, pleurisy, or pneumonia. In one case it was caused by effusion into the brain, and in another, my own, by rupture of the aneurismal sac into the thoracic cavity. In the tables of Dr. Norris, showing the mortality in 69 cases in which the subclavian artery was tied for aneurism, including 9 of wounds of the axillary artery and 2 of tumors not aneurismal, although supposed to be so at the time, 36 recovered, and 33 died.

According to Professor Parker, the subclavian artery has been ligated 81 times, with

29, or 35.80 per cent. of deaths, for idiopathic and traumatic axillary aneurisms. Of 57 idiopathic cases, 21 died, while of 24 traumatic cases, 8 proved fatal. Le Fort has collected 97 cases of ligature of the third portion of the subclavian for wounds, or for diffused and circumscribed aneurisms of the axillary artery. Excluding the wounds, there were 80 deligations for aneurism, with 29 deaths, or a mortality of 36.25 per cent., which corresponds very closely with the results obtained by Parker. Of the 80 cases, 9 were examples of diffused aneurism, with 5 deaths, and 71 examples of circumscribed aneurism, of which 24 died. Wyeth's tables embrace 75 cases in which the subclavian was tied in its third course on account of axillary aneurism with 47 recoveries, or a death-rate of 37 per cent., in which secondary hemorrhage played a conspicuous part. To these cases may be added a successful one recently reported by Harrison, of Liverpool.

In three of the cases mentioned in my paper, the subclavian was secured on the tracheal side of the tumor, and all proved fatal. In one of the cases, that of Mr. Colles, the ligature was not tightened till the fourth day after the operation, owing to the supervention of excessive dyspnœa and cardiac oppression.

In my own case, a traumatic one, the tumor burst at the end of the twenty-sixth day after the operation, discharging its contents into the right thoracic cavity, and thus causing fatal pleuritis. The patient, a man thirty-six years of age, was suddenly seized with intense pain in the chest, which was particularly severe at the base of the right lung, from which it extended over towards the sternum, on the one hand, and up towards the axilla, on the other. The respiration was hurried, laborious, and fifty-six in the minute ; and the pulse, which was quick and tense, rose rapidly to one hundred and forty. Two days after the accident, the patient experienced a sensation near the upper part of the chest, as if a fluid were passing from the pleural cavity into that of the aneurismal sac, and, on carefully auscultating the spot, a splashing sound could be distinctly heard at every inspiration, the noise resembling that produced by shaking water in a closed vessel. The respiration in the right lung was now bronchial, and there was extensive dulness on percussion of that side of the chest. It is proper to add that the tumor prior to the operation was about the volume of a large fist, and that the ligature, which had been placed on the artery on the external side of the scalene muscle, came away on the fourteenth day. The dissection revealed the following facts, the arteries having previously been injected.

The wound made in the operation was completely cicatrized, and the pectoral muscles, although somewhat attenuated, retained their natural appearance. The subclavian artery terminated abruptly at the outer margin of the scalene muscle, where the ligature had been applied, its caliber being closed by a mass of solid fibrin, about one-third of an inch in length, which adhered firmly to the lining membrane, and thus afforded an effectual barrier to the passage of the blood. Between this and the thyroid axis the vessel was occupied by a dark coagulum of blood, which, as it was unadherent, was probably formed only a short time before death. Beyond the seat of the ligature the artery had a rough, ragged appearance, and was sufficiently pervious to admit of the ready passage of a small probe into the aneurismal sac. Superiorly the tumor was overlapped by the brachial plexus of nerves, while in front, at its lower part, was the subclavian vein, which, besides being thrown out of its natural course, was considerably diminished in size. No pus was anywhere discoverable, the parts immediately involved in the operation being intimately consolidated by plastic matter. The aneurismal tumor, placed immediately below the clavicle, was of a conical form, and about the volume of a moderate-sized orange, being two inches and a quarter in diameter at its base. Its walls varied in thickness at different points from half a line to the eighth of an inch, and its interior communicated by means of an oval aperture, one inch and three-quarters in length by an inch and a half in width, with the pleural cavity ; it was situated between the first and second ribs, nearly equidistant between the sternum and spine, and was obviously the result of ulceration, induced by the pressure of the tumor. Both ribs were denuded of their periosteum immediately around the opening, and the serous membrane had a shreddy, ragged aspect. The aneurismal sac contained a few reddish clots arranged in a laminated manner, and closely adherent to its inner surface, especially at the part corresponding with the apex of the tumor.

The right thoracic cavity contained nearly three quarts of bloody-looking serum, intermixed with flakes of lymph and laminated clots, the latter of which were of a reddish-brown color, and had evidently been originally lodged in the aneurismal sac. The pleura exhibited everywhere marks of high inflammation, while the right lung was greatly reduced in volume, from the compression of the effused fluid. The left lung was considerably engorged, and at one or two points almost hepatized. The heart and pericardium were

sound. The abdominal viscera presented nothing unusual. None of the arteries were diseased.

There can be no doubt, from the manner in which this case terminated, that the ulceration which gave rise to the opening above referred to, and which finally led to the escape of a portion of the contents of the aneurismal sac, commenced prior to the deligation of the artery, having been produced by the violent pulsatory action of the tumor. Could such an accident have been foreseen, I should not have hesitaed to empty the sac to relieve the parts of pressure, objectionable as such a procedure certainly would be in ordinary cases.

An instance of a character similar to the above occurred in 1823, in the practice of Mr. Bullen, of England, and is related in the twentieth volume of the London Medical Repository. The patient was a man, thirty-six years of age, and the aneurism, which was of nearly five months' standing, also occupied the right side. Eighteen days after the operation, the tumor began to increase in size and to become painful. Very soon evidences of suppuration appeared, and at the end of a week, from six to eight ounces of bloody pus were ejected during a violent paroxysm of coughing, the sac immediately diminishing one-half in volume. A puncture being made into the swelling, five ounces of a similar fluid were discharged, to the great relief of the patient. It was now apparent that there was a cavity between the first and second ribs, near their sternal extremities, through which the matter had found its way into the lung, and which now readily admitted air from the latter organ, whenever the man coughed, at which time a little also escaped at the artificial opening. By degrees, the discharge of matter ceased, the cough grew less and less, and at the end of three months the recovery was perfect.

Dr. Thomas G. Morton, of this city, in 1866, met with a case of spontaneous aneurism of the axillary artery, in a man fifty-one years of age, in which he successfully tied the subclavian artery on the left side, between the scalene muscles, the ligature coming away on the eighteenth day. Subsequently, however, the tumor sloughed, followed, on the forty-third day, by violent and frequently recurring hemorrhage, and eventually by gangrene of the limb, necessitating amputation at the shoulder-joint. Notwithstanding these untoward occurrences, the patient made an excellent recovery.

Mr. Erichsen, struck with the extraordinary mortality after ligation of the subclavian artery, in the third part of its course, for spontaneous aneurism in the axilla, determined, if possible, to ascertain the cause of death. For this purpose he analyzed 48 cases of the operation, of which 23 recovered, and 25 were fatal. Of the latter, 10 perished from inflammation within the chest, 6 of suppuration of the sac, 3 of hemorrhage, 1 of gangrene of the hand and arm, 1 of suppurative phlebitis, and 1 of general gangrene, the cause of death in 3 not being mentioned.

The ten cases in the first category died of pneumonia, or of this disease and of inflammation of the pleura and pericardium, produced, as Mr. Erichsen suggests, either by an extension of the inflammation of the deep connective tissue of the neck to the contents of the chest, by the inward pressure of the aneurismal sac, or, lastly, by the injury inflicted during the operation upon the phrenic nerve.

Suppuration of the sac was the immediate cause of death in six cases, and it occurred also in two of the cases that died of inflammation of the chest. Besides these fatal cases there were six of recovery, making thus an aggregate of 14 cases, or a ratio of nearly one in three. The period at which the suppuration set in varied, on an average, from eight days to four weeks.

Hemorrhage proved fatal in three of the cases, and appeared to be a frequent cause of death after suppuration of the sac. It may proceed from the distal orifice of the artery opening into the sac, or from one of the large branches in its immediate vicinity, as the subscapular or posterior circumflex.

Gangrene of the hand and arm was the cause of death in one instance only, although the disease occurred also in two others. In Blizard's case, in which there was sloughing of the sac and pericarditis, the gangrene was confined to two fingers; while in Brodie's case it occurred both in the upper and lower extremities, thus showing that it depended, not upon a want of power in the collateral circulation, as in the other examples, but upon some peculiar state of the constitution.

Ligation of the axillary artery below the clavicle has been practised in 21 cases, with 8 deaths, or a mortality of 38 per cent. Not only is the ratio of deaths slightly greater than that of ligation of the third portion of the subclavian, but the operation is not so safe as the latter procedure, especially in cases of spontaneous aneurism, as the artery is liable to be diseased, thereby enhancing the risks of hemorrhage upon the separation of the thread.

Arterio-venous aneurism of the axillary artery has been observed in two cases by Lar-

rey, as the result of sabre-thrust, and by Dupuytren, Wattman, Legouest, and others, in consequence of gunshot injury. The case of Wattman occurred in 1843, in a man, sixty-two years of age, in whom the subclavian artery was ligated in the third portion of its course. A fatal termination ensued in the third week, from hemorrhage. In the other instances, surgical interference was not deemed either necessary or advisable.

ANEURISM OF THE BRACHIAL ARTERY AND ITS BRANCHES.

Spontaneous aneurism of the brachial artery and of its terminal branches, the radial and ulnar, is extremely uncommon, for the reason, adverted to in a previous section, that ossification and fatty degeneration of the coats of these vessels are of such great rarity compared with the same lesions of the femoral and its principal divisions. Of fourteen cases of spontaneous aneurism of the brachial artery, including one of his own, analyzed by Dr. L. E. Holt, of New York, in the American Journal of the Medical Sciences, for April, 1882, the tumor was seated at the bend of the elbow in six, in the lower third of the vessel in two, the middle third in two, at the junction of the middle with the upper third in one, and in the upper third in three. Of the thirteen which underwent treatment two recovered and one failed after instrumental compression; one was cured by combined mechanical pressure and flexion; one recovered after digital compression; and the remainder were cured by ligation of the brachial in four, the axillary in three, and tying the artery above and below the tumor in one. Ligature of the axillary was followed by secondary hemorrhage in two instances, and by suppuration and excision of the sac in the third case. Spontaneous aneurism of the ulnar and radial arteries is spoken of by several writers, but in so vague a manner as to render it difficult to determine whether the disease depended upon degeneration of the coats of the vessels, or merely upon laceration by external injury.

All these arteries are subject to traumatic aneurism; the brachial, however, is much more frequently involved than the radial and ulnar, and one of the most common causes of the occurrence is venesection at the bend of the arm, the puncture of the lancet establishing a communication between the vein and the artery, thus giving rise to what is called an arterio-venous aneurism. Or, instead of this, the instrument may almost completely sever the artery, and so induce a diffused aneurism, not opening into the vein, but sending its contents, up and down, over a large portion of the inner and fore part of the limb. Some of these latter cases are occasionally very formidable, requiring great judgment and skill for their successful management. A good illustration of the traumatic form of aneurism of the brachial artery is afforded in fig. 341.

An *arterio-venous aneurism* at the bend of the arm may sometimes be cured by systematic compression of the brachial artery, at a distance of five or six inches from the seat of the disease; but, in general, the most expeditious plan is to lay open the sac, turn out its contents, and tie the artery above and below, the inferior ligature being necessary to prevent hemorrhage from the recurrent branches.

Fig. 341.

Traumatic Aneurism of the Brachial Artery.

In extensive extravasation of blood, constituting what is usually, but improperly, called a *diffused aneurism*, the brachial artery must be exposed at the site of injury, and ligated at its cardiac and distal extremities. Compression is commonly useless.

Aneurisms of the ulnar and radial arteries must be managed upon the same general principles as those of the brachial artery. Compression can rarely be rendered available, except at the wrist, and even here it will usually be found to be unsatisfactory, on account of the difficulty of maintaining it in a firm and steady manner. Hence, the proper way is always to ligate the affected vessel at once, not waiting until the parts have become obscured by the extravasated blood. As both arteries are very deep-seated in the upper and middle portions of their extent, rendering it very difficult to expose them, it has been proposed, when they are wounded in these situations, to ligate the brachial; but the objection to this procedure is that, while the cardiac extremity of the affected vessel will thus be closed, the distal one will remain patent, and thus admit of a continuance of the hemorrhage by the recurrent circulation.

A case of aneurism of the lower part of the radial artery, caused by a rupture of this vessel in an effort which the patient made to raise himself in bed upon his hands, has been recorded by Sir Astley

Cooper. It was promptly cured by the application of two ligatures. In a case in the practice of Langenbeck, a cure was effected in twenty-four hours by a single subcutaneous injection of ergotin.

The symptoms of aneurism of the radial artery at the wrist are sometimes singularly simulated by the existence of a synovial cyst or ganglion, immediately under the vessel, within the sphere of its pulsation. Not less than five or six cases of this kind have occurred in my practice, most of them in young females in the higher walks of life. The tumor varies in size from a marrowfat pea to that of a hazelnut, and is remarkably dense and firm, with a slight degree of elasticity. The artery, stretched across it like a tense cord, beats with great vigor, and imparts to the finger of the surgeon the sensation precisely of an aneurism. The deception will be much increased if, in addition to this sensation, there is considerable pain in the part, with a feeling of stiffness in the joint. The diagnosis is determined by placing the hand in a state of forced flexion, which, by removing the tension from the tumor, either arrests the pulsation in the vessel, or changes its relation in such a manner as to lead at once to the detection of the true nature of the affection.

Mr. Pilcher met with an instance of aneurism under the ball of the right thumb in a goldsmith, from the repeated, although slight, blows inflicted with his hammer in the exercise of his trade. The disease speedily disappeared after ligation of the radial and ulnar arteries at the wrist. In a case in the practice of Mr. Syme, in a man who had, at the root of the thumb, a tumor about the size of a flattened gooseberry, all pulsation had ceased at the end of twenty-four hours under the pressure of a small spring truss applied to the vessel at the wrist. Guattani describes a case of aneurism of the muscular eminence of the thumb in a man, forty-five years old, which he cured by direct compression after it had been freely opened by a longitudinal incision. The tumor was of the size of a common apple, circumscribed, tense, indolent, and unattended with pulsation.

ANEURISM OF THE ABDOMINAL AORTA.

Aneurism of the ventral aorta is much more frequent in men than in women, and is met with chiefly between the ages of thirty and fifty. In an instance recorded by Mr. Armitage the disease occurred at the age of seven years and a half, the tumor being situated at the bifurcation of the vessel, and death being caused by the rupture of the sac. The disease, which is much less common than aneurism of the thoracic aorta, generally begins near the cœliac axis, in the form of a sac-like expansion, connected with the antero-lateral aspect of the vessel, and communicating with it by a rounded opening, from the size of a quill to that of a finger. The volume of the tumor is variable; in some cases it may not exceed an orange, while in others it may equal an adult's head. Its contents, at first fluid, soon become solidified, and arrange themselves in the form of concentric lamellæ, the number and firmness of which are often very remarkable. The sac usually inclines a little to one side, generally to the left, as there is less resistance in that direction than in the other; and, as it increases, it seriously encroaches upon the abdominal viscera, and even upon the diaphragm, especially when it is of large bulk or situated high up. The immediate cause of the disease is commonly the fatty, fibrous, or calcareous degeneration of the artery.

The symptoms of aneurism of the ventral aorta resemble, in general terms, those of aneurism of the thoracic. The pulsation, however, is usually more distinct, while the functional distress is less, owing to the more yielding character of the abdominal viscera, and the fact that they are not so important to life. The tumor, which is immovably fixed, is dull on percussion, especially in the flaccid condition of the bowels, and gradually increases in size and solidity with its age. The pain, at first slight, often becomes very severe, and usually darts about in different directions. It is generally most violent in the course of the solar, cœliac, and hypogastric plexuses, and occasionally assumes a decidedly neuralgic character. When the vertebræ are eroded, the pain is of a boring nature, more fixed, and attended with a greater amount of sympathetic disturbance. Dyspeptic symptoms are frequently present; and respiratory embarrassment invariably exists whenever the aneurism seriously encroaches upon the diaphragm.

The diagnosis of ventral aneurism is sometimes very difficult. The most reliable considerations are derived from the history of the case, the sudden nature of the attack, the existence of a pulsating and gradually enlarging tumor, with a distinct bellows sound heard over the inferior dorsal, or the upper lumbar, vertebræ, and the great pain, which is experienced in the situation of the disease, both in front and in the back, in the latter of

which it is never absent. The affections with which the malady is most liable to be confounded are, abnormal pulsations of the ventral aorta, whether arising from anemia, neuralgia, or inflammation of its coats; hydatids of the liver; enlargement of the pancreas; carcinomatous and other tumors of the omentum, stomach, colon, mesentery, or ovary; intestinal concretions; indurated feces; and abscesses of the walls of the abdomen. In order to render the examination perfectly satisfactory, the bowels should be well emptied

Fig. 342.
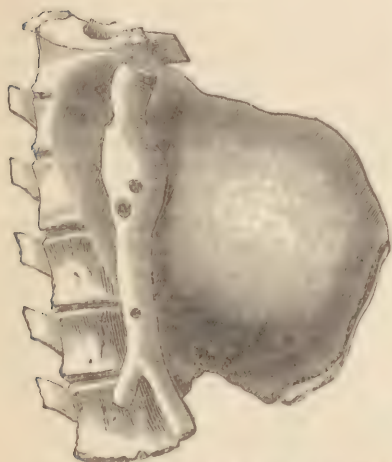
Aneurism of the Aorta, inducing Caries of the Vertebræ, and fatal Compression of the Spinal Cord.

as a preliminary step, when the patient should be placed in the horizontal position, with the abdomen raised somewhat higher than the chest. In this way the tumor will not only become more conspicuous, but the blood will rush into it with greater force, and thus produce more active pulsation and bellows sound. A case has been recorded by T. Spencer Wells in which a large aneurism of the lower part of the aorta was tapped through the vagina, on the supposition that it was a pelvic abscess.

Although a case of spontaneous cure of an aneurism of the abdominal aorta is occasionally met with, the prognosis is extremely unfavorable. The disease almost invariably proves fatal, death occurring either from sheer exhaustion, or from rupture of the sac behind the peritoneum, or into the peritoneum, the intestine, bladder, chest, kidney, or inferior vena cava. The period at which this event takes place varies from a few months to several years. In the case from which the annexed cut, fig. 342, from Jones and Sieveking, was taken, the aneurism produced fatal compression of the spinal cord.

It may be stated as an interesting fact, not without practical significance, that in every case of spontaneous cure of aneurism of the aorta that has ever been reported the patient was in a wasted and exhausted condition, equivalent to that produced by the treatment of Valsalva.

The *treatment* in most cases is mainly palliative, our chief dependence being placed upon rest, a properly regulated diet, and anodynes, in union with aconite, ergot, and acetate of lead. If the patient is plethoric, blood may occasionally be taken from the arm, to moderate the force of the circulation and to subdue pain.

When the aneurism is situated some distance below the diaphragm, and is not very large, experience recently furnished shows that the case may yield to rapid and persistent compression under chloroform, a method successfully practised by Murray, of Newcastle-on-Tyne, in 1864, upon a man twenty-six years of age. A tourniquet was applied above the tumor, and pressure kept up for two hours, but without any perceptible change. Three days afterwards the pressure was renewed, with the result, at the end of five hours, of the perfect consolidation of the swelling, followed by so rapid a cure that the patient was soon able to resume his occupation as a laborer. He survived the operation six years, when he died from the effects of another aneurism of the aorta situated too high up for compression. The dissection showed that the circulation within the abdomen, after the cure of the tumor, had been carried on between the middle colic of the superior mesenteric and the left colic of the inferior mesenteric arteries, including the sigmoid and hemorrhoidal branches, between the upper and ilio-lumbar, and between the inferior lumbar and circumflex iliac arteries. The arteries concerned in maintaining the collateral circulation on the outside of the abdomen were the internal mammary and deep epigastric, the hepatic and a branch of the epigastric, and the intercostal and the two epigastric, with the superficial and circumflex iliac. The superior mesenteric artery was as large as the aorta.

The operation of Murray has also been successfully practised by Moxon and Durham, Greenhow, and Philipson. It has, however, failed in the hands of Mr. Pollock, and proved fatal in the cases of Sir James Paget, and Durham, the causes of death having been peritonitis and abscess in the mesentery, and bruising of the pancreas. In two cases the pad of the tourniquet was applied on the distal side of the aneurism. In that of Skerritt, the patient died from rupture of the sac, and the case of Marshall was a failure. In the case of Bryant, which was also one of distal compression, the aneurism after death

proved to have been connected with the cœliac axis.   It thus appears, that, of 9 cases of proximal or distal compression for aneurism of the abdominal aorta, 4 were cured, 2 failed, and 3 died; results which are so brilliant and creditable as to render the procedure one of the established usages of surgery in a class of cases formerly regarded as utterly hopeless.   Ligation of the aorta for the cure of its own aneurisms must always necessarily be fatal.

Sir William Fergusson, in a case of aneurism of the abdominal aorta, tied the femoral artery, but, with the exception of a diminution of pulsation for a single day, no effect was produced on the disease.

Electrolysis has occasionally been tried in the treatment of aneurism of the abdominal aorta; but, beyond an apparently trifling amelioration, with no ulterior benefit.   Indeed, it is questionable whether, as a rule, the remedy does not do more harm than good.

The aorta may be the seat of *varicose aneurism*, caused by a communication with the vena cava by ulceration or external injury.   The occurrence is uncommon.   The tumor is of variable size and shape, compressible, especially in its earlier stages, and readily detectable by the finger.   The pulsation is generally less distinct than in ordinary aneurism, and there is occasionally a loud whizzing noise heard both by the patient and the attendants.   In a case of varicose aneurism of the aorta and left common iliac vein, under the care of Mr. Simon, compression of the former vessel terminated fatally from gangrene of the intestine.

ANEURISM OF THE BRANCHES OF THE ABDOMINAL AORTA.

Aneurism of these vessels has been observed in a few rare instances, the order of its occurrence being the superior mesenteric, the splenic, the hepatic, the cœliac axis, and the renal.   The subject is of interest chiefly in a diagnostic point of view.   In a case of aneurism of the left gastro-epiploic artery, recorded by Dr. Allé, death was caused by the rupture of the sac, from inordinate exertion in dancing.   The patient was a young woman, in the fifth month of her pregnancy, and the abdomen was filled with blood, partly fluid, partly coagulated.

In aneurism of all these vessels, except the hepatic, the renal, and the cœliac axis, the tumor is always movable, changing with the patient's position, circumscribed, more or less globular, and accompanied by pulsation as it is pushed from side to side.   In an interesting case of aneurism of the hepatic artery, recorded by Dr. Stokes, the sac was bound down by the capsule of Glisson, and lay in close contact with the biliary ducts, which were remarkably dilated throughout the liver, forming tortuous projections on its peritoneal surface.

Besides the pulsation which is always present in aneurism of these arteries, the pressure of the tumor upon the liver and gall-bladder not unfrequently causes jaundice, while its pressure upon the pancreas occasions imperfect duodenal digestion, as indicated by the pain, flatulence, acid eructations, and vomiting some time after taking food.   In a number of the recorded cases troublesome hematemesis existed.

In two cases of aneurism of the trunk of the superior mesenteric artery observed by J. Arthur Wilson, of London, the most prominent symptom in one was jaundice, in the other vomiting of blood.   Both patients complained of severe and constant pain in the middle of the back, between the shoulders.

The great uncertainty in the diagnosis of aneurism of these vessels teaches the necessity of the most careful examination in all cases of doubt, not only with the eye and finger, but the ear.   The detection of various sounds, as the bellows, sawing, or purring, in connection with the existence of a movable tumor, could not fail to throw important light upon the nature of the complaint, and thus protect the patient from the employment of harsh and useless remedies.

ANEURISM OF THE COMMON ILIAC ARTERY.

The history of aneurism of this vessel remains to be developed.   Nothing short, in fact, of a careful analysis of the various recorded cases of it can place it in its true light. That the disease is extremely uncommon in its occurrence is a circumstance which has long been familiar to surgeons.   The table of Mr. Crisp supplies only two cases of aneurism of this artery in 551 cases of the lesion, as it shows itself in different portions of the arterial system.   Both occurred in males.   In one, the tumor was seated on the right side; the patient was a sailor, exposed to hard labor in whale-fishing; the aorta was tied by Dr. Murray, of the Cape of Good Hope, but the man died twenty-three

hours after the operation. In the other case, the aneurism, also seated on the right side, was of a fusiform shape, and communicated with the common iliac vein. No operation was performed.

Varicose aneurism of the common iliac artery is very uncommon. Only a few well-authenticated cases of it are upon record. Of these, one of the most interesting is that observed by Mr. Adams, of Dublin, which seems to have been of spontaneous origin. The patient, who expired one day within a few hours after having taken a walk, had labored for several years under a tumor at the lower part of the abdomen, accompanied with severe pain and throbbing. The dissection revealed a fusiform dilatation of the primitive iliac, with an opening, at one side, of the diameter of a goose-quill, with which it communicated with the corresponding vein.

In a case observed by Leflaive, in a man, twenty-two years of age, the aneurism was caused by the thrust of a knife into the abdomen, a little below the umbilicus, towards the right side. The accident was followed by excessive swelling of the lower extremities, especially the left, by great enlargement of the veins, and, finally, by the formation of numerous troublesome ulcers, from the effects of which the man eventually perished. A tumor, extending nearly as high up as the bifurcation of the aorta, existed between the primitive iliac artery and vein; its walls were ossified, and its cavity was partially filled with fibrinous concretions. The artery bore evidence of former injury.

ANEURISM OF THE EXTERNAL ILIAC.

Aneurism of the external iliac is a rare affection. In the table of Mr. Crisp, the most elaborate hitherto furnished, it occurs only 9 times in 551 cases, while the femoral is mentioned 66 times, and the popliteal 137 times. In 364 specimens of aneurism, contained in the London museums, the same writer found the external iliac affected in 7 cases, the femoral in 12, and the popliteal in 50. The nine cases analyzed by Mr. Crisp all occurred in males: two between twenty and thirty, four between thirty and forty, one at forty, and one at fifty-six, the age of the other not being given. The disease is most common in hard working persons. One of the worst cases of it that I have ever seen occurred in a priest.

The tumor in this disease may be seated in any part of the artery, but, in general, it will be found rather low down, and, as it progresses, it manifests a tendency to pass underneath Poupart's ligament into the upper part of the thigh. It usually rapidly augments in size, and is capable of attaining a large bulk, encroaching upon the iliac fossa and the pelvic cavity, lifting up the peritoneum, and pressing forward the structures in the inguino-femoral region, so as to give rise to great deformity in this situation. The pulsation, thrill, and bellows sound are usually very distinct. If the patient is very thin, compression of the abdominal aorta will arrest the movements of the tumor, and diminish its volume, thus serving to distinguish it from other affections. The diagnosis is, nevertheless, not always so easy as might at first appear. Several cases have been reported where the common iliac artery was ligated on account of morbid growths, supposed to be aneurismal, which afterwards proved to be of a malignant character. On the other hand, a tumor really aneurismal has occasionally been confounded with one altogether of a different character. Such a mistake is most likely to happen when the aneurism is partially solidified by coagulation of its contents, thereby preventing the perception of pulsation. It is only necessary to allude to the possibility of such an occurrence in order to put the practitioner upon his guard in his investigations.

When an aneurism of the external iliac artery has attained a considerable bulk, the patient walks with extreme difficulty, and is unable to flex the thigh upon the pelvis. The whole limb is enlarged and œdematous from obstruction to the return of the venous blood, while the pressure of the tumor upon the femoral nerve keeps up constant pain, with a sense of numbness and stiffness in the parts below, generally extending as far down as the foot and toes.

Aneurism of the external iliac artery, left to itself, proves fatal in one of three ways, by rupture and hemorrhage, gangrene of the sac or limb, or constitutional irritation. Occasionally a spontaneous cure occurs.

Varicose aneurism of the external iliac artery, an exceedingly uncommon affection, may be caused, as the same disease elsewhere, by ulceration or external injury, as a stab, puncture, or gunshot wound. The symptoms present nothing peculiar. The most important, perhaps, is the extraordinary purring, whizzing, or whirring sound which the blood makes as it rushes from the diseased vessels into the intervening sac. The tumor is capable of acquiring a large bulk, and it is impossible always to distinguish it satisfactorily

from an ordinary aneurism. If compression fails, as it will be likely to do, the only resource is ligation of the common iliac, as in the interesting case of Professor Hargave, of Dublin. Although the patient, a soldier, forty-three years old, died on the seventy-third day, the operation, so far as the artery was concerned, was perfectly successful, the ligature having come away nearly a month and a half previously without a drop of blood. The immediate cause of the disastrous result was an enormous abscess of the pelvis, attended with hemorrhage.

ANEURISM OF THE INTERNAL ILIAC AND ITS BRANCHES.

Aneurism of the internal iliac, gluteal, and sciatic arteries is very uncommon, and its history has not been studied with sufficient care to enable us to present anything like a satisfactory account of it. Owing to the deep situation of the former of these vessels, the diagnosis of aneurism occupying its course would necessarily be attended with considerable difficulty, and should not be declared without a good deal of reserve and circumspection. Perhaps the best way of arriving at a satisfactory conclusion, is by the rectal exploration, as originally suggested by Professor Henry B. Sands, of New York. Indeed, in no case of suspected pelvic aneurism, should this mode of examination be neglected or overlooked. Aneurism of the sciatic and gluteal arteries is more frequently traumatic than spontaneous. In fat, muscular subjects the disease is generally difficult of recognition, and hence it is not surprising that solid growths have sometimes been mistaken for it. Mr. Guthrie and Dr. Morton each tied the internal iliac artery for a tumor which had been taken to be aneurismal, but which, after death, was found to be of a sarcomatous character, the deception having been caused by the circumstance of the tumor having received a distinct impulse from the artery. I have not met with aneurism of the pudic artery, and am not aware that the disease has ever been observed in this country. Mr. Erichsen states that the only instance of the kind with which he is acquainted is exhibited in a preparation in the Museum of the College of Surgeons at London.

Dr. George Fischer, of Hanover, has collected thirty-five cases of traumatic and spontaneous aneurisms of the gluteal and sciatic arteries, of which three-fourths affected the former vessel. They may be distinguished from each other by their seat, those of the gluteal artery being generally situated at the upper border of the great sciatic notch, while aneurisms of the sciatic artery are situated nearer to the tuberosity of the ischium, from which they extend towards the thigh or reach into the pelvis. Laying open the sac and ligaturing both ends of the divided vessel have been employed in six instances of traumatic gluteal aneurism, with four recoveries, one failure, and one death from hemorrhage. In the spontaneous and traumatic aneurisms, ligation of the internal iliac has been performed in thirteen cases, with six recoveries and six deaths, the result in one being uncertain, and ligature of the common iliac in three instances, all of which died. Galvano-puncture was tried in one case, but without benefit, while the injection of perchloride of iron was followed by four recoveries and two deaths.

Aneurism of the gluteal and sciatic arteries may be treated by ligating the internal iliac, by rectal compression, or exposing the sac by a free incision, turning out its contents, and tying the vessel above and below. Such a procedure would, unquestionably, be very bloody, but far less hazardous in the end than the deligation of the internal iliac.

The gluteal artery has been tied at least twice in this country for the cure of aneurism; once by Dr. Davidge, of Baltimore, and once by Dr. George McClellan. The tumors being of great bulk, the incisions were obliged to be unusually large, and the loss of blood was very profuse. Notwithstanding this, however, both patients made an excellent recovery. Professor Campbell, of Montreal, has successfully ligated the gluteal artery for a traumatic aneurism of that vessel. Sappey, of Paris, and Dr. Dugas, of Georgia, have tied the sciatic artery for aneurism. The case of the former was not cured, although the patient recovered; while the case of the latter terminated fatally four days after ligation of the common iliac artery for secondary hemorrhage.

TREATMENT OF ILIAC ANEURISMS.

In the treatment of aneurism of the common and external iliac arteries, compression should always be resorted to before operative interference is instituted. If it be possible, the pad of Pancoast's tourniquet should be applied to the common iliac trunk, but as this is more difficult of execution than compressing the abdominal aorta, the latter vessel is to be preferred. Of 11 cases treated by this measure, 8 were cured, and 3 were failures. In the cases of Heath and Murray, consolidation of the contents of the sac was effected.

respectively, in twenty and forty-five minutes. The patient of Professor Agnew was cured by maintaining the compression under ether for two hours on one day, and for half an hour, without an anæsthetic, on the following day.

Cases of Iliac Aneurism, treated by Ligation of the Abdominal Aorta.

No.	Operator.	Date.	Sex.	Age.	Result.	Remarks.
1	Cooper	1817	M.	38	Died in 40 hours	The operation was performed for aneurism of the left iliac artery. The tumor was of enormous size, and extended four inches above and four inches below Poupart's ligament ; the thread was applied three-quarters of an inch above the bifurcation of the aorta. The sac contained an immense quantity of clotted blood.
2	James	1829	M.	44	Died in 3½ hours	There was an external iliac aneurism, for which the femoral was ligated. Increasing in size, 33 days afterwards the aorta was tied. The ligature was applied eleven lines above the bifurcation of the vessel, and five below the mesenteric artery.
3	Murray	1834	M.	33	Died in 23 hours	There was an extensive aneurism of the right external iliac, the tumor reaching as high as the umbilicus, and more than half-way across the lower part of the abdomen. Mortification of the limb was rapidly approaching when the operation was performed. The aorta was tied about four lines above its bifurcation.
4	Monteiro	1842	M.	31	Died in 10 days	A large tumor occupied the lower part of the abdomen and upper part of the thigh. It was a spurious aneurism of the femoral artery, caused by the bursting of that vessel. The patient died, at the expiration of ten days, of secondary hemorrhage, from a small opening in the vessel corresponding with the knot of the ligature, which had been applied four lines above the point of bifurcation.
5	South	1856	M.	28	Died in 43 hours	The aneurism occupied the external and common iliac, and was of immense size. The ligature was applied a little above the bifurcation of the aorta.
6	McGuire	1868	M.	30	Died in 11 hours	The operation was undertaken with the view of tying the common iliac, but after it was begun it was found that the aneurism involved the external iliac on one side, both common iliacs, and the lower extremity of the aorta. The sac burt during the operation, without much hemorrhage, and a ligature was hastily cast around the aorta at the origin of the inferior mesenteric artery, the cord, as was found after death, including the left ureter.
7	P. H. Watson	1869	M.	...	Died in 65 hours	Secondary hemorrhage after ligature of the common iliac nine weeks before ; cut through the mesentery, and at the same time secured the external and internal iliac branches of the same side, to prevent recurrent bleeding ; did well for two days ; no further hemorrhage ; limbs regained their temperature after operation, but it sank 6° in the affected leg prior to death.
8	W. Stokes	1869	M.	50	Died in 12 hours	Aneurism involved the right common iliac, the external iliac, and femoral arteries. Pulsation returned in the sound femoral artery in nine hours.

Digital compression has been tried in several cases of ilio-femoral aneurism, but only in one successfully—a patient of Dr. Nichols, of New Orleans—after an effort of thirty hours. In a similar instance, in charge of Dr. R. J. Levis, a cure was effected with the aid of ether in less than six hours by mechanical compression applied to the external iliac. In a former edition of this work I expressed the opinion that an aneurism of the external iliac might generally be promptly obliterated, especially in its earlier stages, by compression of that vessel as it passes over the brim of the pelvis ; and Dr. T. R. Varick, of Jersey City, acting upon the suggestion, in June, 1880, employed it successfully in a case of inguinal aneurism in a man forty-eight years of age. The pressure was applied with a Ricord's bubo compressor over the ramus of the pubes, and was kept up for forty-eight hours, a small slough following the operation. This mode of treatment is certainly

entitled to a fair trial.   Digital compression would, I think, be preferable to any other, on account of the greater facility of its application, and the avoidance of all risk.

If compression fail, the only recourse is deligation of the artery leading to the tumor, the external iliac, when the aneurism is situated low down so as to leave a sufficiency of the vessel in a suitable condition for the reception of the ligature; or, when the reverse is the case, the common iliac; or, when the latter is implicated, the abdominal aorta.   The result of ligation of the external iliac is encouraging, since of 169 cases in which it has been tied for all causes, only 61, or 36.09 per cent. died.   Ligation of the common iliac, on the other hand, is one of the most formidable operations in surgery, 49 or 77.77 per cent. of the 63 cases in which it has been practised for various affections, having perished. The table, p. 770, indicates the results of eight cases in which the abdominal aorta has been tied for iliac aneurisms, the case of Mr. Stokes being included, although Porter's wire compressor was employed instead of an ordinary ligature.

It will be perceived from the table that the eight cases in which the abdominal aorta has been tied terminated fatally; a result which might assuredly have been foreseen by the distinguished surgeons who performed the operation.   Questionable as the propriety of such an operation is, I should, I confess, be strongly tempted to perform it if my patient were placed in circumstances precluding all hope of relief from any other source. That this was the feeling which prompted Sir Astley Cooper, in 1817, to undertake it, and which has since induced others to imitate his example, is more than probable, and our only regret is that their efforts were not crowned with success.   What the effect might have been if the cases had been of a more favorable nature prior to surgical interference is, of course, merely a matter of conjecture, but it is perfectly evident, from their history, that they were all in as desperate a condition as they could well have been at the time. The tumor, in every instance, was of enormous volume, almost, in fact, ready to burst: in Mr. Murray's patient there was, besides, incipient gangrene of the lower extremity. In the case of Mr. James, an error of diagnosis had been committed, which led, improperly, as was afterwards proved, to ligation of the femoral artery, thereby causing the patient not only much suffering but the loss of much valuable time, upwards of four weeks having elapsed between the two operations.

In performing the operation, the peritoneum was divided in three of the cases, and left intact in five; in one instance, it was opened to the extent of nearly four inches.   Such a procedure would probably of itself have been a cause of death, had the patient survived the immediate effects of the deligation of the vessel.

The case of Dr. Monteiro, the most successful of all, is replete with interest, as it establishes the fact that the circulation may go on in the lower extremities, after the flow of blood in the abdominal aorta has been completely arrested by the ligature.   The patient survived the deligation ten days, when he died of secondary hemorrhage, caused by a small aperture in the side of the vessel corresponding with the knot in the thread.   The dissection showed that the peritoneum, which had not been cut in the operation, was perfectly free from inflammation.   The aorta had been ligated four lines above its bifurcation, and an inch below the inferior mesenteric artery.   The aneurism, which was a false one, had originated in a rupture of the superior extremity of the femoral artery, from which the blood had made its way upwards, underneath Poupart's ligament, through the intermuscular connective tissue, into the iliac fossa, and thence on behind the peritoneum along the posterior part of the abdomen, as high up as the diaphragm and liver. The common and external iliac arteries were involved in the tumor, and were in an inflamed and friable condition.   The external wound had nearly healed.

It is worthy of remark that the pulsation in the tumor ceased immediately on tying the ligature, but returned slightly on the third day, and became more marked on the fourth. Hemorrhage supervened the day before death.   The operation was followed by coldness of the lower extremities, but in four hours afterwards this had passed off, and the temperature rose a little above the natural point.   No paralysis of the limbs was at any time present.

In addition to the foregoing eight cases, the aorta has been tied twice by Czerny, on account of hemorrhage.   In the first case the femoral and common iliac arteries had been previously ligated for bleeding from a gunshot wound of the thigh, and the patient died in twenty-six hours.   In the second case the operation was resorted to for the arrest of hemorrhage from a torn renal artery in removing a kidney for malignant disease, and the patient survived ten hours.

In a remarkable case of traumatic aneurism of the external iliac, in a seaman, thirty-one years of age, Mr. Syme, in 1862, laid open the sac, to the extent of six inches, turned

out a mass of blood and fibrinous clots, to the amount of six pounds, and tied the common, internal, and external iliac arteries where they communicated with the tumor. The circulation in the aorta was controlled by a compressor fastened around the abdomen. The edges of the wound were united by silver sutures, covered with dry lint, and gently supported by a bandage. Although the ligatures dropped off on the nineteenth day, the patient remained in a very precarious state until the end nearly of the third month, when so decided an improvement took place as to remove all doubt as to his ulterior recovery. A short time after this, however, he contracted a severe cold, from the effects of which he soon died. The enormous tumor, prior to this bold and brilliant operation, extended, on the one hand, from below Poupart's ligament considerably above the umbilicus, and, on the other, from nearly two inches beyond the middle of the abdomen, towards the right side, completely across the left iliac region, so as to overlap the crest of the iliac bone. Another remarkable circumstance in the case was the small amount of suppuration that followed the opening of the sac.

ANEURISM OF THE FEMORAL ARTERY.

Aneurism of the femoral artery is very common, although less so than that of the popliteal. In Mr. Crisp's cases, 551 in number, 66 relate to the femoral artery, of which 61 occurred in males, thus showing that the disease is very rare in women. The period of life at which it is most frequently met with is from thirty to fifty. As in the other arteries, aneurism of the femoral is most common in the laboring classes, particularly in those persons who are subject to severe muscular exertion of the lower extremities, causing a sudden strain upon the vessel. Instances have been observed in which each femoral artery was simultaneously affected with aneurism, and it occasionally happens that the same vessel has two such tumors connected with it.

The femoral artery is not equally subject to aneurism in all parts of its extent. The superior third suffers more frequently than the rest of the vessel, and spontaneous aneurism occurs here much oftener than in any other external artery, except the popliteal. Sailors are said to be particularly liable to the disease in this situation, owing, as Mr. Crisp supposes, to the violent flexion and extension of the thigh which they are obliged to make in mounting the rigging and performing other labor on shipboard. I have never seen an instance of spontaneous aneurism in the lower third of the thigh, and general experience concurs in declaring that such an occurrence is extremely uncommon. In some of the published cases, the disease is described as having been femoro-popliteal, a term evidently intended to convey the idea that the lesion involved both the terminal portion of the femoral and the superior portion of the popliteal.

Diagnosis.—The diagnosis of femoral aneurism, although generally easy, is sometimes involved in so much obscurity as to cause not a little perplexity. This is more especially the case when the tumor is seated along the middle or lower third of the thigh, where the artery is tightly bound down by the muscles and aponeuroses. Abscesses and various morbid growths, solid, semisolid, or fluid, and malignant and non-malignant, are the affections with which it is most liable to be confounded ; and it behooves the surgeon, in every case of doubt, to institute the most careful and thorough examination before he expresses an opinion in regard to its character, or permits himself to engage in any operative procedures for its relief. The best diagnostic, unquestionably, is the effect which compression of the femoral artery exerts upon the tumor, when it is situated some distance below Poupart's ligament, or of the ilio-femoral, when it occupies the superior part of the thigh. If the tumor is aneurismal, the compression will not only arrest its pulsation, thrill, and bellows sound, but, while it is being kept up, it will enable the surgeon to squeeze out its contents, and thus greatly diminish its volume, circumstances which cannot possibly occur when the swelling is of a non-aneurismal character, whatever may be its structure or consistence. The exploring needle is only to be used in cases not admitting of discrimination by this method, and then it should be so fine as not to cause hemorrhage or excite inflammation. It is worthy of note, in a diagnostic point of view, that the tumor in aneurism of this vessel almost invariably springs from its anterior surface.

The femoral artery, in the upper portion of its extent, is sometimes protruded forward by a *synovial burse*, situated behind the psoas muscle, just below Poupart's ligament, especially when the pouch is inflamed and much distended, in which case it will probably receive an impulse from the vessel, so as to cause the swelling to simulate aneurism. The proper way to determine the diagnosis is to flex the thigh upon the pelvis, a procedure

which, by taking off the tension of the muscles, puts a stop to the pulsation of the tumor, and thus reveals the true nature of the disease.

A number of *lymphatic glands* lie in the upper part of the thigh, immediately upon and around the femoral artery. Enlargement of these glands has been mistaken for aneurism, and, conversely, aneurism for enlargement of the glands; but the history of the case and a careful examination of the parts will generally promptly clear up the diagnosis.

Psoas abscess occasionally points below Poupart's ligament, and might be mistaken, by a careless observer, for aneurism of this vessel, or of the external iliac. The best diagnostic signs are the want of pulsation, the soft and fluctuating character of the swelling, the absence of discoloration of the skin, and our ability to efface the swelling almost entirely when the patient lies on his back with the thigh and pelvis a good deal elevated. Moreover, if there be any pus, a drop will be sure to follow the withdrawal of the exploring needle.

Progress.—The course of the aneurism is variable. When it is situated high up, it is liable, in its progress, to extend upwards, and to project at length beneath Poupart's ligament into the pelvic cavity. When, on the other hand, it involves the inferior portion of the artery, it may pass down into the ham, and so simulate popliteal aneurism. The swelling usually increases rather rapidly, and, in time, often spreads over a large space, diffusing itself, in fact, widely, in consequence of the giving way of the two inner tunics of the artery. When this is the case, the limb below the seat of the tumor becomes greatly enlarged and œdematous, from obstruction to the return of the venous blood, and the patient constantly complains of stiffness, pain, and numbness in it, extending generally as low down as the feet and toes. In the more advanced stages of the disease, progression becomes difficult and finally impracticable, the whole limb feeling like a dead, heavy mass. A spontaneous cure occasionally occurs, as in a case from which the adjoining cut, fig. 343, was taken; but most commonly the disease goes on from bad to worse, until life is destroyed by gangrene, excessive suppuration, hemorrhage, or constitutional irritation.

Fig. 343.

Spontaneous Cure of an Aneurism of the Femoral Artery by the Sac being filled with Coagulum; the Vessel remaining pervious.

Treatment.—The treatment of aneurism of the superficial femoral artery may, I think, generally be successfully conducted by compression, especially now that our means of applying and regulating it are so much better understood than formerly. The compression may be made either with the finger or by means of one of the numerous mechanical contrivances before the profession. In the case of a negress, aged thirty-two, who was under the joint care of Dr. S. W. Gross and myself, in 1859, on account of a large aneurism of the upper third of the femoral artery, the assistants succeeded in effecting complete solidification of the contents of the sac in forty-six hours, by digital compression alone. The tumor progressed most favorably, and in less than three weeks after the operation the woman was able to walk about the house. In this case, referred to in a previous section, there was not more than an inch of space between the aneurismal sac and Poupart's ligament, in consequence of which the compression was obliged to be applied to the iliac artery as it passed over the brim of the pelvis. Several instances of an equally gratifying termination have followed this treatment in the hands of other surgeons. In a case of aneurism of the femoral artery, the size of a small orange, six inches below Poupart's ligament, in a man seventy-eight years old, under the charge of Mr. F. R. P. Drake, of England, in 1873, a rapid cure followed digital compression maintained for ninety minutes.

In a case of aneurism of the upper portion of the femoral artery, in a man thirty-eight years of age, under the charge of Dr. Buckminster Brown, of Boston, in 1863, a cure was effected by direct compression of the tumor by means of a pad, accurately fitted to the swelling, and secured around the pelvis by a belt, the degree of pressure being regulated most of the time by two cannon balls, one of twelve and the other of twenty-four pounds, each applied on every alternate day. The patient was confined to his back for ten months,

and retained under surveillance upwards of six months longer. The tumor extended as high up as the brim of the pelvis, and was three inches and a half in diameter. Full particulars of the case are given in the Boston Medical and Surgical Journal for March, 1866.

Several instances of aneurism of the femoral artery cured by flexion of the thigh upon the pelvis have lately been reported, one, among others, by Dr. Buck, of New York, and the treatment is well worthy of further trial, especially in cases of recent standing and of small size.

When compression and flexion are inapplicable, the only resource, of course, is deligation of the artery which supplies the tumor with blood. The operation is easily done at Scarpa's triangle when the aneurism occupies the middle or lower third of the femoral artery, or even when it extends up to the inferior portion of this space, provided the coats of the vessel are sufficiently sound to bear the pressure of the ligature. When this is not the case, or when the tumor is situated high up, near Poupart's ligament, or projects beneath it partly into the pelvic cavity, the remedy usually adopted is ligation of the external iliac, an operation which, although not devoid of risk, has now been performed so often and so successfully as to be justly ranked among the established resources of surgery.

Ligation of the external iliac is generally regarded as a much safer operation than ligation of the common femoral. Of 12 cases referred to by Mr. Erichsen, in which the latter vessel was secured, under such circumstances, secondary hemorrhage occurred in 9, of which 3 proved fatal. The causes of this disaster are usually supposed to be the great shortness of the common femoral artery, and the numerous branches that are detached from it and the external iliac, rendering it thus very difficult for a solid coagulum to form above the ligature.

These statistics are in striking contrast with those of the Dublin surgeons, who, in 8 cases of this operation, have not had a solitary death. The first operation was performed, in 1849, at the Meath Hospital, by the late Professor William H. Porter, and the next by his son, Mr. George H. Porter, in 1860. The vessel, in this situation, is quite superficial, and is easily exposed by a short horizontal incision, half an inch below Poupart's ligament. The femoral vein lies at its inner side, and is, of course, carefully avoided.

During the past five years the old operation of opening the sac, and taking up both ends of the vessel, has been successfully performed by Mr. Birkett and Mr. Cooper Forster on account of rupture of the sac, and by Mr. John Gay in a case in which the sac was perfect. In the first two instances the circulation was controlled by the abdominal tourniquet.

A number of cases of femoral aneurism have been recorded in which a cure was effected simply by refrigerant applications to the tumor, aided by steady compression with the bandage, strict recumbency, and an abstemious regimen. This treatment has occasionally succeeded both in the spontaneous and traumatic form of the disease.

A singular case of aneurism of a large anomalous artery of the thigh has been recorded by Mr. C. H. Fagge in Guy's Hospital Reports for 1864. The vessel arose from the internal iliac artery, ran down the back of the thigh, and terminated in the popliteal, as the main artery of the lower extremity.

Mortality.—In Mr. Crisp's 66 cases, above referred to, the external iliac alone was tied in 44, and in two others both this artery and the femoral ; 36 of the patients recovering and 10 dying. Of the latter, three perished from hemorrhage, four from gangrene of the sac or limb, one from tetanus, one from exhaustion, and one without any apparent cause. In 12 of the cases the femoral artery alone was tied, with a result of 9 cures to 3 deaths. Amputation was successfully employed in five cases ; in two the tumor was obliterated by compression, and in one the disease spontaneously disappeared.

In the table of Dr. Norris, comprising 118 cases of ligation of the external iliac artery, of which, however, 97 only relate to aneurism, 85 recovered, and 33 died, three of the former having undergone amputation of the limb in consequence of gangrene. In 4 of the 97 cases of aneurism the disease existed simultaneously both in the thigh and in the ham, and in 3 of these the operation succeeded in curing both tumors. A return of pulsation in the sac took place in 9 cases, and hemorrhage in 14, of which 7 proved fatal, and 7 recovered. In 10 cases the tumor suppurated after the operation, although they all ultimately did well. Gangrene of the limb occurred in 16 cases out of the 118, of which 12 died. In two instances the peritoneum was wounded, but both patients recovered. To these cases may be added 51, of which 35 were analyzed by Dr. Cutter, of Newark, and 16 are tabulated in Circular No. 6. Of the entire number, or 169, 61, or 36.09 per cent.,

died. In 126 cases, the vessel was tied for aneurism, with a result of 35 deaths, or a mortality of 27.77 per cent.

Varicose aneurism of the femoral artery and vein is occasionally observed. The accident is commonly produced by external injury, as a gunshot, knife, or sabre wound, but it may be also caused by ulceration; and Baroni has related a case in which it followed upon a contusion of the thigh. The treatment should, as a general rule, be entirely of a hygienic character, experience having proved that operative interference is usually followed by fatal results. In some of the recorded cases of this affection the patients lived for many years, in one as many as twenty, in comparative comfort.

In a case of this description, in a lad, fifteen years of age, in consequence of a stab with a knife, Professor Spence, of Edinburgh, succeeded in curing the affection by ligating the superficial femoral artery above and below the aneurism, without opening the sac. In a similar operation, in the hands of Malgaigne, the patient died from the combined effects of hemorrhage and profuse suppuration.

A very interesting case of *aneurismal varix* of these vessels was kindly brought to my Clinic at the Jefferson Medical College, in 1864, by Dr. W. B. Atkinson. The man had been wounded a year previously by a musket ball. He experienced no inconvenience whatever from the disease.

ANEURISM OF THE DEEP FEMORAL ARTERY.

Aneurism of this vessel is extremely uncommon, and I am not aware that it has ever been observed in this country. Mr. Erichsen refers to five cases, which, he says, are the only ones of which he could find any record; and Mr. Bryant has met with another case. This remarkable exemption from disease is the more surprising, when it is remembered how very liable the deep femoral artery is to calcification and atheromatous degeneration, the ordinary predisposing causes of spontaneous aneurism. Traumatic aneurism, the result of gunshot injury and fracture of the thigh-bone, is more frequent.

The symptoms of aneurism in the deep femoral artery present nothing peculiar. The pulsation is easily arrested by compression of the external iliac at the groin, and the superficial femoral is without difficulty drawn away from the tumor, so as to show its independent character. Care must be taken not to mistake the disease for a malignant growth. The sac seldom attains any great bulk. The treatment usually suggested is ligation of the external iliac; but were I to meet with such a case, I should certainly tie the common femoral, immediately below Poupart's ligament, as a far safer procedure, with a temporary ligature, removed at the end of forty-eight hours.

In a case of this disease, treated by Mr. Erichsen, in 1870, all pulsation in the aneurism, one of large size, was arrested in twenty-four hours by means, first, of Carte's compressor, and afterwards by the finger, applied to the common femoral artery. The patient, for a considerable portion of the time, was under the heavy influence of a large dose of chloral.

ANEURISM OF THE POPLITEAL ARTERY.

The extraordinary frequency of aneurism of the popliteal artery has long been familiar to pathologists and surgeons. With the exception of the thoracic portion of the aorta, there is no artery in the body which is so often the subject of this disease. The table of Mr. Crisp, already so frequently referred to, comprises an analysis of 551 cases of spontaneous aneurism, of which 137 occurred in the vessel under consideration, the thoracic aorta suffering 175 times. Three circumstances seem to serve to establish this extraordinary liability to aneurism on the part of this artery; one is its extreme proneness to ossific and fatty degeneration, another, the curve which it forms behind the knee, and the third, the sudden and forcible extension to which it is so constantly exposed in the various movements of the lower extremity. Broca ascribes the great frequency of the disease to the pressure to which the popliteal artery is subjected in the ring-like opening in the soleus muscle.

Age and Sex.—Popliteal aneurism occasionally occurs at a comparatively early age, a number of cases having been observed in which it took place before the twenty-fifth year. Mr. Syme has related one in a child of seven years. The great majority of instances, however, are met with between thirty and fifty. Both sides seem to suffer nearly in an equal degree, and both are occasionally affected simultaneously, or suc-

cessively, as I have myself witnessed in several individuals. The disease is almost peculiar to men. In Mr. Crisp's cases, 137 in number, 133 occurred in males, and only 4 in females. No occupation is exempt from aneurism of the popliteal artery, but the stastistics which have been published upon the subject conclusively show that the laboring classes, especially soldiers, sailors, bargemen, and porters, who are in the constant habit of making long-continued and violent exertions of the muscles of the lower extremities, are more liable to it than any other. The idea, first broached by Morgagni, that postillions and coachmen are particularly prone to popliteal aneurism, has been proved to be erroneous.

Diagnosis.— Aneurism of the popliteal artery is probably produced in most cases by a sudden and violent sprain or twist of this vessel while its coats are in a state of calcareous degeneration, and, consequently, deprived of their elasticity, by which they are prevented from following the various movements of the leg with their accustomed freedom, a sudden rupture being thus induced, of which the patient is himself often made conscious, either by his feeling, or by a kind of snapping noise. The tumor, being at first quite small, generally escapes attention until it has acquired a considerable bulk, as, from the great depth at which the artery is situated, and the unyielding nature of the parts in the ham, it takes some time for it to reach the level of the surrounding surface, or to exhibit to the eye the characters of a distinct swelling. A careful examination, however, will always enable us, even at an early period, to arrive at a satisfactory conclusion respecting the nature of the case, except, perhaps, in very fat subjects. The tumor will be found to throb synchronously with the artery in the groin, and, by grasping it firmly between the thumb and finger, it may readily be pushed about in the hollow between the tendons of the flexor muscles, feeling like an elastic, circumscribed knob, which is easily diminished by pressure, but immediately regains its former size when the pressure is removed. As the disease progresses, the sac increases in volume, and encroaches more and more upon the popliteal space, pushing aside the soft parts, compressing the popliteal vein and nerve, and interfering seriously with the movements of the limb. The leg is habitually bent at an obtuse angle with the thigh, and all efforts to straighten it prove abortive; it is the seat of constant aching pains, with a sense of numbness or tingling; its temperature is notably diminished, and its subcutaneous connective tissue, owing to the obstruction to the return of the venous blood, is loaded with serum, or serum and lymph, giving the surface a glossy, shining appearance, and causing it to pit under pressure. The ear and the hand readily detect the characteristic thrill and bellows sound.

Aneurism of the popliteal region is liable to be confounded with various kinds of tumors, and we read of cases in which the sac was laid open under the impression that the disease was not arterial. The lesions for which it is most apt to be mistaken are abscesses, solid and fatty growths, and synovial burses.

Abscess of the ham is of very uncommon occurrence, and is generally easily distinguished by its inflammatory character, and by the history of the case, and by the absence of pulsation, by the presence of fluctuation, especially when the matter is considerably in quantity, and by our inability to produce any change in the volume of the swelling by compression of the femoral artery high up in the thigh. When any doubt exists, a small exploring needle, carefully inserted into the tumor, will readily determine the diagnosis.

Solid growths, of various kinds, benign and malignant, are liable to form in the popliteal region, and might be mistaken for aneurism, especially by a careless and inexperienced surgeon. The fact that such tumors are usually stealthy in their origin, tardy in their development, firm in their consistence, and free from pulsation, will always readily distinguish them from aneurism of the popliteal artery.

A *synovial burse* is occasionally developed in this space, but the occurrence is rare, and it would be difficult to imagine how such a growth as this should ever be confounded with an aneurism in this region. In the Louisville Medical Review, a case of this affection is reported by Dr. S. W. Gross, in which the largest tumor of this description that I have ever seen, occurring in a man twenty-nine years of age, was readily diagnosticated by the exploring needle, although its history—especially the absence of pain and pulsation, its non-interference with the patient's occupation, and the preservation of the natural appearance of the leg below the knee—had been sufficiently denotive of its true nature without any expedient of this kind.

Progress.— Aneurism of the popliteal artery may remain circumscribed for a considerable length of time; in general, however, it soon becomes diffused, and by its pressure upon the surrounding structures causes not only great pain and swelling in the leg below

the knee, but a tendency to mortification by cutting off the nervous and vascular supplies. Such a termination, in fact, is almost inevitable if the case be permitted to proceed unchecked. Gangrene may occur at a very early stage of the disease, while the tumor is yet quite small, by its direct pressure upon the lower part of the popliteal artery, or upon its immediate offsets. Generally speaking, however, it is one of the more remote effects of the disease, as the gradual or sudden destruction of the more attenuated portion of the sac, and the escape of its contents into the neighboring tissues, rendered thus additionally tense by the unyielding aponeurosis. In this manner, an aneurism originally circumscribed, and, perhaps, quite small, may, in a few hours, become widely diffused and of enormous bulk, obscuring the pulsation both in the tumor and in the distal portion of the limb, if, indeed, not completely arresting the circulation. Similar effects often follow upon what is improperly called a diffused traumatic aneurism, in which the blood escapes more or less rapidly from the wounded vessel, and inundates the surrounding structures, frequently to a great and most injurious extent, arresting the circulation, and occasioning gangrene of, perhaps, a large portion of the limb below the seat of the compression. The foot and leg are cold, heavy, insensible, œdematous, of a speckled, glossy, or tallowy hue, and exquisitely painful. The patient, weak and feverish, soon becomes delirious, and, if relief be not promptly afforded, dies from exhaustion. Occasionally a popliteal aneurism discharges its contents into the knee-joint, where they speedily set up violent inflammation, necessitating amputation.

Sometimes a spontaneous cure occurs, probably by the pressure of the tumor upon the artery, or the detachment of a clot, thereby arresting the circulation in the sac. The late Professor Pancoast had a case of popliteal aneurism upon which he had intended to operate the next day; but when the time arrived all pulsation in the tumor had ceased, and the man gradually recovered without any further trouble.

Treatment.—The treatment of popliteal aneurism was, until recently, usually conducted by deligation of the femoral artery in the superior third of the thigh, according to the method of John Hunter, first practised in 1785. Since 1840 numerous cases have been treated by other means, more especially compression in its several forms, and so gratifying have been the results, in most instances, that the old operation is likely, before long, to become, in great measure, obsolete. Of 403 cases, analyzed by Professor Agnew, 250 were cured. Blackman effected a cure by digital compression in two hours; Holt, in sixteen hours; and Bryant, in one case, in four hours and a half, and in another, in twenty-four hours. Examples, equally remarkable, have occurred in the practice of other surgeons. On the other hand, in a case of my own, digital compression was incessantly maintained for four days and a half without any benefit whatever, a cure being afterwards readily effected by ligation of the femoral artery. Dr. James R. Wood, in 1850, published an account of two cases of popliteal aneurism successfully treated by the joint agency of mechanical and digital compression. Dr. Cheever, of Boston, effected a cure by acupressure of the femoral artery; and in a case reported by Herbert Page, of England, a similar result followed the manipulation of the sac. Mr. Henry Lee, in a case of traumatic aneurism of the ham, was also successful with acupressure.

Digital compression for the cure of popliteal aneurism is generally applied to the common femoral artery immediately below Poupart's ligament, and mechanical compression to the superficial femoral, in Scarpa's triangle. The pressure, however, may, from time to time, be shifted from one point to another, according to the tolerance of the patient, who should be freely narcotized during the whole course of the treatment.

Forced flexion, described at p. 720, is particularly applicable to aneurism of the ham, and always deserves a fair trial, if the tumor is not so large as to encroach seriously upon the structures of the joint or to threaten to discharge itself into its interior. In a case which I treated, in 1861, at the College Clinic, in a man thirty-five years of age, all pulsation in the aneurism ceased in less than twenty-four hours. The disease had come on three months previously, from a severe strain. The tumor was of an elongated, oval shape, large, circumscribed, and characterized by the ordinary phenomena. A number of examples of popliteal aneurism successfully treated by this method have occurred within the last ten years.

When compression and forced flexion fail, or when the case is not a suitable one for such procedures, the only resource is ligation of the superficial femoral artery in the lower part of Scarpa's triangle, where the vessel, although closely invested by the femoral vein, is always easily exposed, the sartorius muscle serving as a guide to the knife. The greatest possible care must be taken in separating the two vessels, as their adhesions are most intimate, and the ligature must be passed from within outwards. As a rule, it is

not advisable to perform the operation until the tumor has acquired a considerable bulk, or until there is reason to believe that the collateral circulation is sufficiently active to enable it to carry on the circulation in the distal portion of the limb after the ligation of the main trunk. The limb, placed in an easy, relaxed position, is enveloped in flannel, and, if need be, surrounded with bottles of warm water, until it has regained its normal temperature, which is often materially depressed after the operation. The feet should be carefully protected from pressure, lest gangrene arise, and everything should be done, by the avoidance of motion and officious interference, to promote the healing of the wound. The patient must not be allowed to sit up in bed, or to move the limb for some time after the detachment of the ligature, otherwise, the adhesions giving away prematurely, secondary hemorrhage might supervene. The ligature is usually detached from the tenth to the thirteenth day.

When ligation, digital and mechanical compression, and forced flexion fail to afford relief, or when, after the employment of these measures, gangrene sets in, the only resource is amputation of the thigh, performed as speedily as possible, after the supervention of the disease. A similar procedure will be required when the aneurism has burst, and sent its contents widely through the connective tissue beneath the skin and among the muscles. Obstinate secondary hemorrhage may also necessitate amputation, although, in such an event, acupressure may occasionally be successfully employed. Partial gangrene, occurring in small spots on the tumor, the leg, or the foot, does not always demand the removal of the limb, especially if the patient is otherwise in good condition.

In two remarkable cases of incipient gangrene due to the interruption of the collateral circulation by pressure of the tumor, the limb was saved, in one by Lawrence, and in the other by Benza, by cutting down upon the sac, laying it freely open, and turning out its contents, a ligature being applied to each extremity of the diseased artery. Such a procedure necessarily involves great risk, both immediate and remote; the former depending upon hemorrhage, which must always be more or less copious; and the latter upon inflammatory irritation and its consequences, as extensive suppuration, ulceration, and sloughing of the exposed structures.

Mortality.—The mortality from the operation for popliteal aneurism by the Hunterian method would seem to be variable. In the table of Dr. Norris, comprising a list of 153 cases of aneurism, for which the femoral artery was tied, 112 were cured, and 41 died. The table of Mr. Crisp furnishes 110 cases, operated upon according to the Hunterian method, of which 91 recovered completely, 7 required amputation after the use of the ligature, and 12 died. Of the 11 cases of double popliteal aneurism comprised in it, all were cured; 10 by ligature, and one by compression. The greatest cause of the mortality after the ligation of the femoral artery is gangrene of the leg.

Of 278 cases collected by Professor Agnew, 173 were perfectly cured. The remarkable freedom from danger in this operation in the hands of certain surgeons is admirably exemplified in the practice of Mr. Syme, who, up to June, 1866, had ligated the femoral artery for the cure of popliteal aneurism in 35 cases, without any bad results, except in a single one, which had previously been subjected to compression, and in which the sac suppurated without any fault of the ligature.

Amputation performed as a means of saving life, in cases of incurable popliteal aneurism, shows a very fair amount of success. There are, however, no statistics by which a comparative estimate may be formed between the results of this operation and the ligature of the femoral artery practised for the cure of this affection.

The ham is occasionally the seat of *aneurismal varix*. One of the most extraordinary cases of the kind on record is that related by Dr. Dorsey, in his " Elements of Surgery." The patient had been wounded in the upper part of the leg twelve years before, by a load of buckshot. The limb was very painful, all the veins were enormously enlarged from the toes to the groin, and incorrigible ulcers existed upon the foot and ankle. The thrill so peculiar to this species of aneurism could be distinctly perceived. The femoral artery was tied at the middle of the thigh; but the operation was followed by mortification of the leg, and during the separation of the slough, one of the enlarged veins suddenly gave way, causing copious hemorrhage, which, although it was for a time controlled by ligating the vessel, again broke out, and finally proved fatal. The femoral artery was in a dilated and unnatural condition as high as the groin, and a bougie was readily passed from the popliteal into the posterior tibial artery, and thence into a venous pouch at the inner part of the leg, below the knee.

Varicose aneurism of the ham is uncommon. Cases of it have been recorded by Larrey, Hodgson, Porter, and other observers, generally as a result of injury, as a punc-

ture or gunshot wound, but now and then as a spontaneous occurrence. The tumor may acquire a large bulk, and be accompanied by excessive dilatation of the popliteal vein. The treatment should be altogether hygienic, except when the disease is productive of great pain and inconvenience, when the sac should be laid open, and the artery tied above and below.

Traumatic aneurism, properly so called, may occur in this region from a sabre wound, a musket ball, or the sharp end of a piece of bone, as in fracture of the femur or tibia. The blood is generally widely diffused, and the diagnosis is often greatly obscured by the attendant swelling. If the symptoms are urgent, the artery should be exposed and ligated at each extremity; otherwise the case should be treated upon general principles, in the hope of gradual ulterior accommodation of the tumor, if not a spontaneous cure.

ANEURISM OF THE ARTERIES OF THE LEG AND FOOT.

Spontaneous aneurism of the arteries of the leg is very uncommon. In a paper, read before the American Surgical Association, in September, 1881, Professor R. A. Kinloch, of Charleston, analyzed 20 cases of spontaneous aneurism of the posterior tibial artery, of which 18 occurred in males, the sex being uncertain in 2. In two the supposed cause was stamping with the foot, and in one, each, pulling on a boot, a fall, standing long in one position, and overexertion, the cause being undetermined in 14. The age of the subjects ranged from nineteen to sixty-six years. The femoral artery was ligated in 12 cases, in three of which compression had previously failed, with a result of 5 cures and 7 deaths. Compression alone was employed in 5 cases, of which 3 were cured and 2 were failures. One of the cures was obtained by Esmarch's bandage. Amputation was resorted to in 5 instances, in only one of which was it the primary plan of treatment, with a result of 3 recoveries and 2 deaths; and in one case the sac was successfully laid open, and two ligatures applied.

The traumatic form of the disease is the most frequent, and there are few lesions in surgery more difficult to manage, especially when the affection involves the posterior tibial artery, owing to the great depth at which this vessel is situated, and the contused condition of the parts arising from the extravasated blood. The proper remedy, of course, is free exposure of the affected vessel, removal of the coagula, and ligation of both ends. To accomplish this to the best advantage, often involves great coolness on the part of the operator, and an unusual amount of anatomical knowledge and dexterity. During the operation, the iliac artery should be compressed at the brim of the pelvis, or a tourniquet be applied around the upper part of the thigh. Without such precaution, the hemorrhage might be frightfully profuse.

In 1873, a man thirty-five years of age, was admitted into the Jefferson Medical College Hospital, under the joint care of Professor Wallace and myself, on account of an aneurism of the posterior tibial artery, the size of a large fist, which had made its appearance eight months previously, in consequence of a wound inflicted by the sharp bony spine of the sting-ray, or trygon pastinaca. After much difficulty, owing to the confused condition of the surrounding structures, I succeeded in tying the artery above and below the tumor, which was thoroughly freed of its contents, but not removed. The man did well for the first forty-eight hours, when erysipelas and pyæmia ensued, from the effects of which he died seven days afterwards.

The annexed cut, fig. 344, affords a good illustration of an aneurism of the posterior tibial artery undergoing spontaneous cure, the sac being filled with concentric coagula. The tibial nerve is spread over the back part of the pouch.

A case of spontaneous aneurism of the dorsal artery of the foot was reported by Mr. Adams, of the London Hospital, in 1877, in a man, twenty-nine years of age. The tumor, the size of a walnut, was situated over the outer side of the astragalo-scaphoid articulation, and had come on without any assignable cause, about one month previously to the admission of the patient. The ligation of the anterior tibial artery in the upper portion of its extent, performed for the site of the disease, was followed by violent inflammation of the foot, necessitating amputation of the leg. The dissection of the parts showed that the aneurism had penetrated the astragalo-scaphoid joint. In a case under my care in 1874, in an old colored man, the aneurism, situated in front of the ankle-joint, had come on spontaneously

Fig. 344.
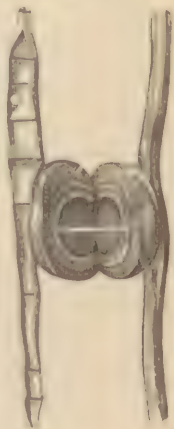
Aneurism of the posterior Tibial Artery, with the Nerve spread over the back part of the Pouch, which is entirely obliterated by concentric Coagula.

seven years previously, and was about the size of a pullet's egg ; the artery was tied above and below the tumor, and then dissected out, but the operation was followed by erysipelas, which ended fatally a few days afterwards.

The traumatic form of the disease has occasionally occurred, chiefly as a result of vene-section, at one time so much in vogue among the common people, especially on the conti-nent of Europe. Examples of the accident have been recorded by Guattani, Roux, Vidal, and other writers. From the firm support which the artery receives as it passes over the tarsal bones in front of the foot, the probability is that such a tumor might easily be obliterated by compression, either digital or mechanical, applied immediately below the ankle-joint. If the effort should fail, the tumor should be dissected out, and the artery tied above and below.

SECT. VIII.—OPERATIONS ON THE ARTERIES.

LIGATION OF THE INNOMINATE OR BRACHIO-CEPHALIC.

Although the innominate may be easily exposed on the dead subject, as was shown by Dr. George McClellan as early as 1820, by a linear incision carried vertically down in front of the trachea, without dividing any of the cervical muscles, yet I believe that such a plan would be ill suited to the purpose when there is a large tumor pressing upon and displacing the parts which environ this vessel. The operator must have ample room, and it will not, I presume, materially affect the issue of the case whether a little more or a little less tissue is cut. The plan suggested by Dr. Mott, in his celebrated case, is, on the whole, it seems to me, the one best adapted for obtaining ready access to this artery, and is that which I should myself follow if I were called upon to secure the innominate for the cure of aneurism. The incision resembles, in outline, the shape of the letter L, the horizontal limb corresponding with the upper border of the clavicle and sternum, and the vertical with the inner margin of the sterno-cleido-mastoid muscle, each being about three inches in length. The lower incision extends as far inwards as the centre of the trachea. The triangular flap thus mapped off, embracing the skin and platysma-myoid, being dissected up, the sterno-cleido-mastoid, sterno-hyoid, and sterno-thyroid muscles are respectively separated upon a director from their inferior connections and turned out of the way. A layer of the deep cervical fascia is now cautiously pinched up and divided, when, by a little scratching with the finger-nail, the handle of the scalpel, or the end of a probe, the carotid will be brought into view a few lines above the top of the sternum, accompanied by the jugular vein and pneumogastric nerve. Taking this vessel as his guide, the surgeon can easily trace the course of the innominate downwards towards the heart, and isolate it from its associate vein. The ligature, when the case admits of it, should be applied about the middle of the vessel, the needle being carried around it from left to right and from behind forwards. When the aorta is situated unusually low, it may be necessary, in order to obtain more easy access to the innominate, to excise, as a pre-liminary step, the external extremity of the clavicle with a small segment of the sternum, as was done by Cooper, of San Francisco, in both his cases.

In performing this operation, it should be remembered that this artery is only about sixteen lines in length ; that it rests upon the trachea, which it crosses somewhat obliquely at the base of the neck ; that the middle thyroid veins, and sometimes the middle thy-roid artery, run along its inner side ; and that on the right side, and on a plane ante-rior to it, is the innominate vein, the two vessels being intimately united together by connective tissue, and in close relation behind with the pneumogastric and phrenic nerves, the latter lying external to the former. The top of the pleura is a little inferior and external to the artery, and might, unless great caution is used, be easily wounded. The middle thyroid artery is sometimes given off by the innominate on its tracheal as-pect, and should be looked for in isolating the vessel, as its division might be followed by annoying hemorrhage.

LIGATION OF THE COMMON CAROTID.

To Mr. Abernethy is usually, but erroneously, ascribed the merit of having first tied the common carotid. From some remarks of Hebenstreit, it appears pretty certain that the operation had been performed some time previously by a surgeon during the extirpa-tion of a tumor of the neck, in which he accidentally divided this vessel, and immediately surrounded it with a ligature, the patient soon recovering. The English surgeon did not

ligate the artery until 1798 ; the case was one of wound of the internal corotid, and the man died in thirty hours. The first operation that was performed upon it for carotid aneurism was by Sir Astley Cooper, in 1805, and was unsuccessful, the case terminating fatally on the nineteenth day. Three years subsequently, he ligated the vessel again, and now with a happy result.

There are two points at which the common carotid may be tied, the place of election being regulated by the circumstances of the particular case. These are the upper and inferior cervical regions, and it will be well, in every instance, before the operation is begun, to call to mind the more important anatomical relations of the parts, otherwise serious blunders may arise, such, for example, as tying the omo-hyoid muscle or jugular vein instead of the artery, or including along with the artery the vessel just named, or some important nerve, as the pneumogastric, sympathetic, or laryngeal. As the artery proceeds upwards, it is overlapped by the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, and crossed by the omo-hyoid towards its superior extremity. Running down in front of its sheath is the descending branch of the ninth pair of nerves, a little, thread-like filament, easily recognized by its whitish appearance, while within the sheath are, on the external side of the artery, the internal jugular vein, and behind and between them the pneumogastric nerve, the sympathetic and recurrent being posterior to the sheath. These relations are very intimate, and, therefore, the utmost caution is necessary in isolating the parts previously to the application of the ligature. The embarrassment is often immensely increased by the manner in which the artery is overlapped by the jugular vein, which occasionally, although less frequently than is generally supposed, swells out enormously during every effort at expiration, so as to obscure the vessel and render its ligation extremely difficult. The best way of remedying this is to request an assistant to compress the vein both at the upper and lower angle of the wound, the blood having previously been pressed out of it.

The common carotid, on the right side, is sometimes absent, its place being supplied by two trunks, which, arising separately from the arch of the aorta, ascend along the neck, assuming the office of the external and internal carotid. When this arrangement exists, which, however, is extremely rare, the order of origin of the branches of the aorta is as follows : the right subclavian, right external carotid, right internal carotid, left common carotid, and left subclavian. It should also be borne in mind that the common carotid may, on the other hand, bifurcate very low down, not perhaps reaching as high up as the inferior border of the thyroid cartilage, and, on the other hand, it may not separate into its terminal divisions until it gets to the angle of the jaw. Morgagni met with an instance in which the artery, only an inch and a half in length, divided at the root of the neck. Lastly, it may be crossed in front by the inferior thyroid artery, lie upon the vertebral artery as this vessel passes along the spine, and include in its sheath the descending branch of the ninth pair of nerves.

In ligating the carotid, the patient should be recumbent, with the head inclined to the opposite side, and well supported by pillows, the shoulders being at the same time somewhat raised, in order to place the neck in a proper horizontal position. In the lower part of the neck the artery may be exposed by making an incision, from two and a half to three inches in length, along the inner border of the sterno-cleido-mastoid muscle, commencing just above the clavicle. The skin and platysma-myoid muscle being divided, a portion of the cervical fascia is pinched up with the forceps, and opened transversely to an extent large enough to admit a grooved director, upon which the membrane is then slit up and down nearly to the length of the outer incision. Two retractors are now inserted into the wound, one being used to draw the sterno-cleido-mastoid muscle outward, and the other to draw the sterno-thyroid inwards toward the trachea. The sheath of the artery being thus exposed, a little piece of it is now raised with the forceps, and divided horizontally, when, the director being introduced, it is slit open so as to denude the artery to a small extent, and enable the operator to isolate it from the jugular vein and the pneumogastric nerve, the ligature being passed from without inwards. Generally a small subcutaneous vein will be found passing along the line of incision, communicating above with the facial vein, and below with the thyroid plexus. This must, of course, be carefully avoided.

The artery being more easy of access in the superior part of the neck than the inferior, this point should always be selected, when this is in our power, for ligating it. To expose the vessel in this situation, an incision should be carried along the inner margin of the sterno-cleido-mastoid muscle, commencing a little below the cricoid cartilage, and reaching nearly as high up as the angle of the jaw. Embracing the integument, platysma-

myoid muscle, and cervical fascia, it will thus conduct the operator at once down to the sheath of the vessel, which is then to be opened in the same cautious manner as in the previous case ; and the artery being gently separated from the accompanying structures, is ligated by passing the needle around it from without inwards, so as effectually to exclude the jugular vein. The omo-hyoid muscle, which crosses this part of the carotid, must be held aside with a hook.

The annexed cut, fig. 345, from Bryant, represents the common carotid as being exposed by a long incision, with a view of showing where it is crossed by the omo-hyoid muscle.

Fig. 345.
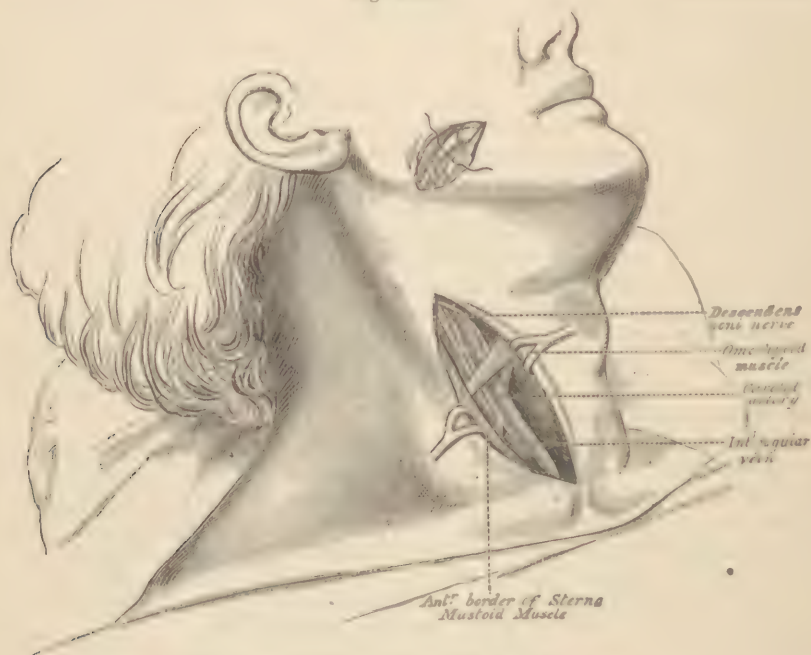
Ligation of the Common Carotid and Facial Arteries.

When access to the common carotid, in the inferior part of the neck, is rendered difficult on account of the low situation of the tumor, the best plan is to divide the sterno-hyoid and sterno-thyroid muscles, either alone, or jointly with the inner portion of the sterno mastoid, so as to enlarge the space between the aneurism and the sternum. By observing this precaution, Mr. Porter, of Dublin, was enabled, in one case, to ligate the vessel successfully within the eighth of an inch of the innominate ; and examples of a similar character have occurred in the practice of other surgeons.

The carotid is sometimes tied at a very early age, as in a case in which I assisted the late Dr. George McClellan, where he successfully secured this vessel in a child five months old, on account of an immense nævus of the upper part of the face. The descending branch of the ninth pair of nerves was divided, as it interfered with the passage of the ligature, without any apparent harm. Dr. Valentine Mott, in a similar affection, tied the common carotid in a child only three months old, the whole of the operation being equally gratifying.

Ligation of the common carotid is occasionally required on account of wounds of the neck involving the external carotid or some of its branches. The first successful case of the kind occurred in 1803, in the hands of Mr. Fleming, an English naval surgeon. The operation is often embarrassing in consequence of the confused condition of the parts from the extravasation of blood, and is, besides, not always successful, owing to the establishment of a return current through the internal carotid into the external carotid. Hence secondary hemorrhage, sometimes of a very profuse character, is liable to ensue, necessitating further proceeding, at a time, perhaps, when the wound is in a high state of inflammation. In order to avoid all this, Dr. Gurdon Buck has proposed the simultaneous ligation of the common and internal carotid arteries, and, in the New York Medical

Times for November, 1855, he has given the particulars of a case in which the operation was followed by the most gratifying results.

Ulcers of the fauces have sometimes necessitated the ligation of the primitive carotid, as in the cases reported by Luke, Mayo, and Syme, in all of which the operation was successful. The patient of the latter, however, came very near perishing from secondary hemorrhage.

The common carotid artery has been repeatedly secured for wounds, ulcers, epilepsy, and erectile and other tumors, as well as for restraining hemorrhage in operations and injuries upon and about the head, ear, jaws, face, neck, mouth, and pharynx. The statistics of these operations present points of much interest, and they have been placed in a very clear light by the tables of Dr. Norris. In 30 cases in which the artery was tied on account of wounds, 15 recovered, and 15 died; in 16 cases in which it was ligated previously to, or at the time of the extirpation of, tumors of the jaw, face, or neck, 8 died; in 6 in which it was tied for the cure of epilepsy, all recovered, from the effects of the deligation, although in 2 both vessels were secured; and in 42 cases in which it was tied for the cure of erectile tumors and various growths of the diploë, orbit, neck, jaw, and maxillary sinus, 20 were cured, 13 died, and 9 recovered from the effects of the operation without being materially benefited. In upwards of 20 of the 94 cases, more or less severe cerebral symptoms followed the operation.

Of 600 cases of ligature of the common carotid artery, analyzed by Dr. C. Pilz, of Breslau, in 1868, 319 were cured, 259 died, and of the remainder the result is not stated. Of 537 cases in which the sex is given, 403 were males and 134 were females. In 578 cases, in which the result is recorded, the ligature was applied in 222 for hemorrhage, in 86 for aneurism, in 136 for tumors, in 63 before and during the removal of tumors, in 34 for nervous affections, and in 37 for Brasdor's operation. In 27 cases both arteries were tied, the right in 251, and the left in 194. In the majority of instances, the ligature was detached after the thirtieth day. Nervous affections followed the operations in 160 cases, and hemiplegia in 8 per cent.

These figures are not materially affected by those of Dr. Wyeth published in 1879. Thus, for instance, of 462 cases of wounds of all kinds for which the common carotid was tied 262 proved fatal. Of these cases 111 were gunshot wounds contracted in military service with a mortality of 81, while of 16 cases in civil life, only 4 died, thus presenting a difference in favor of the latter of 48 per cent., due mainly to the milder form of the injury, and to the less amount of shock. The table of Dr. Wyeth includes 52 cases of ligation for non-malignant tumors of the orbit, of which 28 were cured, 6 died, 5 were improved, and 6 were not benefited. Of 71 operations performed for the relief of aneurism by anastomosis, not affecting the orbit, 51 recovered, with 20 cures, and 20 died. Of 166 cases in which the artery was tied for sacculated aneurism 76 died, and of the 90 recoveries only 66 were cured. Of the 166 cases the artery was tied on the cardiac side of the tumor in 106, of which 37 perished, and 90 recovered with 60 cures. Of 60 cases in which the ligature was applied at the distal side of the aneurism 39 died, and 21 recovered, but only 6 were permanently relieved.

Wyeth's tables comprise 789 cases of ligation of this artery for all causes, of which 323, or 41 per cent., perished. Of the 466 cases reported as having recovered, only 255 were cured, 42 were improved, 14 temporarily benefited, and 53 unimproved. The principal factors of death in the fatal cases were, hemorrhage, exhaustion, and cerebral disturbance, or interference with the functions of the brain, from the want of blood, and other causes. Paralysis followed the ligation of the artery in 52 of the 789 cases. Of the 323 fatal cases 7½ per cent. occurred within the first 24 hours after the operation; 23 per cent. within three days; 45 per cent. within one week; 64 per cent. within a fortnight; and 75 per cent. within twenty-one days. The same artery was tied twice in 8 instances with six fatal results, and in one thrice followed by death. The right artery was ligated in 361 cases, and the left in 290 of the 651 in which the seat of the operation is stated. The ligature was detached on an average, from the tenth to the twenty-fourth day. Among the great dangers after the operation are softening of the brain and inflammation of the air-passages. A very distressing symptom occasionally witnessed is violent hiccough, due, apparently, to compression of the pneumogastric nerve by the ligature.

In wounds of the neck, involving the great vessels, the common carotid should never, as has been justly remarked by Dr. Wyeth, be tied for injury of the external carotid, or of its branches, when there is space enough between the seat of the lesion and the bifurcation of the common carotid to admit of the application of a ligature to the external carotid. He bases this conclusion upon the fact that the death-rate in 789 cases tabulated

by him of ligation of the common carotid is 41 per cent., while that of the external carotid in 91 cases is only 4½ per cent. He also lays great stress upon an analysis of 121 dissections made by him with a view of determining the relations of these arteries and of their branches to each other. He condemns, in pointed language, the teaching which advises the ligation of the common trunk instead of the external carotid when there is sufficient space between them to place the ligature; he declares that the practice, hitherto almost universal, is as wrong in principle as it is dangerous in its results, and should therefore be abandoned.

The following table affords a summary view of nearly all the examples in which both these vessels have been tied, either simultaneously or after a variable interval.

Ligation of both Carotids.

No.	Operator.	Date	Age	Sex	Diseases.	Interval.	Result.	Remarks.
1	Dupuytren and Robert	1819	...	...	Anastomotic aneurism of scalp.	36 years	Died	Brain symptoms.
2	Macgill	1823	...	F.	Fungous tumor of both orbits.	1 month	Recovered	Improved. Vision destroyed before operation.
3	Ullman	1823	20	...	Erectile tumor of orbit.	12 months	Died	Death on 3d day from hemorrhage.
4	Mussey	1827	20	M.	Anastomotic aneurism of scalp.	13 days	Recovered	Failed. Pulsation returned in tumor, which was excised after second operation.
5	Mussey	1827	19	...	Anastomotic aneurism of scalp.	28 days	Recovered	
6	Möller	1831	4½	...	Erectile tumor.	4½ months	Recovered	
7	Preston	1831	24	M.	Epilepsy.	39 days	Recovered	Failed. Convulsions the day after each operation.
8	Preston	1831	51	M.	Epilepsy.	84 days	Recovered	Failed. Fits had existed for six years, latterly palsy on one side.
9	V. Mott	1832	...	M.	Epilepsy.	6 months	Recovered	
10	V. Mott	1833	...	M.	Disease of parotid.	15 min.	Died	Death in forty-eight hours.
11	Kuhl	1834	53	M.	Aneurism of occiput.	72 days	Recovered	
12	Hamilton	1838	18	M.	Epilepsy.	6 months	Recovered	Last operation followed by destructive inflammation of the left eye.
13	Velpeau	1839	29	...	Aneurism of both orbits.	3 months	Recovered	
14	V. Mott and Eve	1839	19	M.	Hemorrhage from nasal polyp.	13 months	Recovered	
15	Pirogoff	1843	20	...	Hemorrhage from aneurism of scalp.	1 year	Recovered	Hemorrhage and vomiting after each operation.
16	J. Ellis	1844	21	M.	Shot wound of tongue.	4½ days	Recovered	
17	Reynolds & Van Buren	1844	11	...	Aneurism by anastomosis.	6 years	Recovered	
18	J. M. Warren	1845	23	M.	Erectile tumor of face.	33 days	Recovered	Failed. Subsequent excision of diseased structure followed by cure.
19	Robert	1846	19	F.	Aneurism of forehead	8 months	Recovered	Headache; temporary disturbance of vision.
20	Blackman	1848	15	M.	Disease of antrum.	21 days	Recovered	Temporary loss of vision of left eye.
21	V. Mott	1851	...	M.	Malignant disease of nose.	5 months	Recovered	
22	W. Parker	1854	45	M.	Malignant disease of nose and orbit.	32 days	Recovered	Died at end of five months from return of the disease.

No.	Operator.	Date.	Age	Sex	Diseases.	Interval.	Result.	Remarks.
23	V. Mott	1854	...	M.	Malignant disease of orbit.	3 months	Died	Death on fourth day.
24	J. R. Wood	1856	53	...	Encephaloid of antrum.	5 months	Died	Death on sixteenth day.
25	Buck	1857	22	M.	Aneurism of orbit.	26 months	Recovered	
26	G. C. E. Weber	1857	20	M.	Epilepsy.	17 days	Recovered	Improved. Disease had existed for five years.
27	Carnochan	1858	44	F.	Elephantiasis of neck, ear, and face	7 months	Recovered	Growth, which had existed for fourteen years, diminished.
28	V. Mott	1858	21	M.	Malignant disease of antrum.	8 months	Recovered	
29	U. S. Army ?	1862	...	M.	Shot wound of neck.	Same day	Died	Death same day.
30	Murdoch	1863	...	M.	Shot wound of neck.	3 days	Died	Death on fifth day after second operation from recurrence of hemorrhage.
31	Longmore	1863	...	...	Shot wound	6 days	Died	Death in thirty-eight hours.
32	Billroth	1864	27	...	Hemorrhage from ulcerated internal carotid artery.	14 days	Died	Secondary hemorrhage on sixteenth day. Death two days after second operation from exhastion.
33	Lewis	1864	...	M.	Shot wound of face.	4 days	Died	Death on ninth day.
34	Parker	1864	38	M.	Malignant disease of antrum.	28 days	Recovered	Disease not arrested.
35	H. E. Foote	1867	20	M.	Orbital aneurism.	30 days	Recovered	Complete cure of aneurism, and marked improvement of vision.
36	Buenger	......	34	...	Aneurism by anastomosis and wound.	5 years	Recovered	Left tied for aneurism, and the right for suicidal wound five years afterwards.

Of the above cases, 36 in number, 26 recovered from the effects of the operation, and 10 died. In the instance of Dr. Mott, in which both vessels were tied almost simultaneously, coma soon supervened, and the man died in forty-eight hours. In the case of Dr. Ellis, of Michigan, the second deligation was performed after an interval of four days and a half, on account of secondary hemorrhage consequent upon a gunshot wound, and no unpleasant symptoms followed, the patient making an excellent recovery. In Dr. Mussey's case twelve days intervened between the two operations, neither of which was succeeded by any accident. To Dr. Macgill, of Maryland, belongs the credit of being the first to tie both carotid arteries on the same subject within a short interval.

Most of the cases marked as recoveries were only temporarily relieved; very few were cured. Most of the cases in which the operations were performed for gunshot injuries perished from secondary hemorrhage. Of 22 operations performed by American surgeons 17 recovered, and 5 died.

LIGATION OF THE EXTERNAL CAROTID AND ITS BRANCHES.

The external carotid, extending from the superior border of the thyroid cartilage to the neck of the lower jaw, is situated, just above its origin, in the triangular space formed by the omo-hyoid muscle below, the digastric above, and the sterno-mastoid externally, immediately beneath the integument and platysma-myoid; but it soon sinks deeper in, passing up under cover of the stylo-hyoid and digastric muscles, and is finally buried in the substance of the parotid gland. It is accompanied by two veins, and is crossed near its commencement by the hypoglossal nerve, and also, in various parts of its course, by branches of the external jugular and other veins. The glosso-pharyngeal nerve is interposed between this artery and the internal carotid, while the superior laryngeal nerve lies under both.

Ligation of the external carotid artery is seldom required except in wounds of the neck

and in vascular growths, as nevoid tumors and aneurism by anastomosis, of the face and scalp. The operation has occasionally been performed as a preliminary step to the removal of the lower jaw and of the parotid gland, but such a measure can certainly rarely be necessary in the hands of a skilful surgeon; and, as for tying this vessel for the cure of carcinoma of the neck, tongue, palate, or pharynx, as has been done by Mutzer, Maisonneuve, and others, I hold that such a procedure, in the face of our present experience, is utterly unjustifiable. The vessel is often opened in attempts at suicide, although less frequently than is generally imagined; for persons intent upon self-destruction usually bend the neck so far back as to place the artery beyond the reach of the knife. Some of its branches are, however, commonly injured under such circumstances, especially the superior thyroid and lingual, and the hemorrhage thus produced may be promptly fatal. A ligature may readily be placed around the external carotid between these two arteries, in the first part of its course, that is, from four to six lines above its origin, and immediately below the digastric muscle, by carrying an incision, about two inches and a half in length, parallel to and about six lines in front of the inner edge of the sterno-mastoid muscle, commencing opposite the middle of the thyroid cartilage, and terminating a short distance below the angle of the jaw. The trunk of the common carotid will guide the finger to its external division; and it will always be well, before the ligature is tied, to feel for the pulsation of the temporal artery. The incision should be made with great care, lest violence be done to some of the numerous offsets of the vessels. The artery, as it lies beneath the digastric and stylo-hyoid, is exposed with difficulty; the incision must be proportionately large, and the muscles just mentioned must be well depressed with the retractor.

Some of the branches of this artery occasionally arise so closely to its origin as to render it improbable that if a ligature were applied at the usual point of election, a sufficiently large and firm clot would form to occlude its caliber securely on the detachment of the ligature. For such a case the safest plan would be to tie at the same time the nearest offset.

Dr. Wyeth, in his statistics, finds that the external carotid artery was tied alone in 67 cases with 3 deaths, and simultaneously with the common carotid in 10 cases, all of which

Fig. 346.
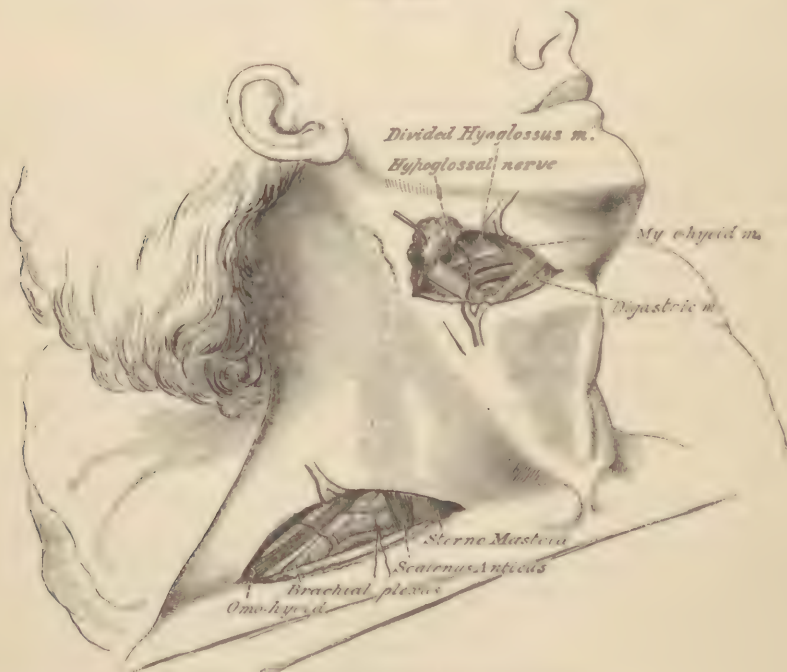
Ligation of the Subclavian and Lingual Arteries.

ended fatally. Of the 64 recoveries, in which the external carotid alone was concerned, only 31 are reported as having been cured. Of the 67 cases, the sex is given only in 47, of which 34 were males, and 13 females. The ligature, in most of the cases, came away before the seventeenth day, in one as early as the fifth day, and in one as late as the twenty-second

day. The artery was tied on both sides in the same patient in six cases, all eventuating in recovery. The causes necessitating the operations were various, as wounds, hemorrhages, tumors, malignant and benign, and vascular growths of the head, ear, face and nose, facial neuralgia, and injury of the external carotid and facial arteries.

The principal branches of this artery, requiring surgical consideration, are the superior thyroid, lingual, facial, occipital, and temporal.

The *superior thyroid artery* is much exposed to injury in attempts at suicide, and may then be easily traced simply by following the wound. If it becomes necessary to ligate it on account of hypertrophy of the thyroid gland, with a view to diminish the supply of blood, it may be laid bare by making an incision across the upper part of the neck, obliquely downwards and outwards from the side of the hyoid bone to the edge of the sternomastoid muscle. Or, instead of this, the object may be attained by making an incision, two inches in length, along the inner border of the sterno-mastoid muscle, as in the operation for tying the external carotid. The skin, platysma-myoid, and cervical aponeurosis having been carefully divided, the superior thyroid will be found deep in the omohyoid space, between the sheath of the carotid and the thyroid gland.

The *lingual artery* may be exposed in the same manner as the thyroid, near which it takes its origin; its situation, however, is very deep, and its relations are so complicated that it generally requires a great deal of skill and perseverance to reach it. Unless the patient is fully under the influence of an anæsthetic, the difficulty of the operation will be much increased by the incessant spasmodic action of the larynx, which, forcing the hyoid bone up and down, renders it very troublesome to fix the points of incision.

If the operation, fig. 346, from Bryant, should be deemed necessary, it may be performed as follows, according to the plan laid down by Mr. Skey in his valuable work on Operative Surgery : " The head of the patient being placed horizontally, and the neck lengthened by raising the chin, an incision of about twelve lines in length should be made immediately behind the cornu of this bone, the outline of which should be distinctly ascertained before proceeding to the operation; the incision should be directed downwards and forwards. The skin and platysma being divided, the fascia is exposed, which should also be divided to the length of the external wound. The facial vein, often of considerable size, will be brought into view at the upper part of the wound, in its course downwards to the internal jugular, and should be drawn outwards. The remaining parts should be torn, rather than cut asunder, passing transversely inwards, nearly parallel to the upper edge of the cornu of the os-hyoides, when the artery will be exposed. In passing the needle behind it, care must be taken to avoid the superior laryngeal nerve, which descends nearly at right angles behind the artery."

Demarquay has tied both lingual arteries on three occasions, to produce atrophy of carcinomatous affections of the tongue, with the result of prolonging life in each case; and a similar operation for gunshot wound of the tongue was successfully performed during the War of the Rebellion.

The *facial artery*, so frequently concerned in operations about the neck, face, and lips, may easily be compressed with the finger as it passes over the jaw. If divided, it should immediately be secured. When its ligation becomes necessary, in case there is no wound, its pulsation will point out the proper situation for the incision. When it is desired to secure it just above its origin, the incision should be made as in the operation upon the lingual, its approach being facilitated by drawing the digastric muscle strongly upwards. The vessel is most easily exposed and tied where it lies over the jaw, as in fig. 345.

The *occipital artery* sometimes requires ligation on account of wounds, but its depth in the lower part of its extent is such as to protect it generally from injury involving the cervical region. On the back of the head, however, it is not unfrequently laid open, and usually bleeds very freely. It may be exposed just above its origin by carrying an incision along the inner border of the sterno-mastoid muscle, in the angle formed by it and the digastric, the latter of which must be well drawn down. It is in intimate relation here with the hypoglossal nerve, which hooks around it as it passes forward toward its destination. The artery, after emerging from the splenius muscle, on the back of the head, fig. 347, is superficial, its course beneath the scalp being denoted by its pulsation. A fatal case, in which, on account of a wound in this vessel, and of the jugular vein, and the confused condition of the parts, a ligature was applied to the common carotid artery by Dr. G. W. Norris, is reported in the American Journal of the Medical Sciences for April, 1856.

The *temporal artery* is occasionally wounded, and may be secured immediately above the zygoma, by a short vertical incision, fig. 348, embracing the temporal aponeurosis,

immediately beneath which it is situated.   Lower down, the depth at which it lies is too great to justify an attempt at ligation.   Should it be divided in this portion of its extent, the best plan is to tie the external carotid.

Fig. 347.

Ligation of the Occipital Artery.

Fig. 348.

Ligation of the Temporal Artery.

The anterior branch of this vessel is the one always selected in arteriotomy, when it is wished to practice depletion on account of affections of the brain, or the brain and its membranes.   After a sufficient amount of blood has escaped, the artery is cut across, and a graduated compress applied.   If this precaution be neglected, a false aneurism will form.

The *internal maxillary artery* is sometimes wounded by a thrust with a sharp knife or dirk.   The immediate result, of course, is a copious hemorrhage, for the arrest of which the only remedy is ligation of the external carotid: compression, it is true, now and then succeeds, but the only reliable means is the ligature.   When the vessel is wounded in the extirpation of the jaw, it may commonly be seized and tied; when this is impracticable, the bleeding may generally be stopped with the hot iron, or with the tampon, wet with a saturated solution of subsulphate of iron.

LIGATION OF THE INTERNAL CAROTID ARTERY.

Ligation of this vessel is rendered necessary for the arrest of hemorrhage, and for the cure of traumatic aneurism, the result of injury inflicted upon its own tunics.   Varying in length in different individuals, the artery extends directly upwards from the upper border of the thyroid cartilage to the carotid foramen of the temporal bone, and is in intimate relation with numerous and most important structures.   Lying deeply in the neck upon the anterior rectus muscle, it is concealed below by the sterno-mastoid muscle, and above by the parotid gland, the internal jugular vein being situated at its posterior aspect, and somewhat superficial to it, the pharynx and tonsil at its inner side, and the pneumogastric and sympathetic nerves deeply behind.   The main trunk of the external carotid is on the outside, and a little in front of it.   Superiorly, the artery is crossed by the digastric and stylo-hyoid muscles, the occipital artery, and the glosso-pharyngeal nerve, and, near the base of the skull, by the styloid process, and the stylo-pharyngeal muscle.

Considering the intricate relations of this vessel, the narrow space in which it is embedded, and the fact that in cases of injury the parts must necessarily be greatly confused by extravasated blood and inflammatory deposits, some idea may be formed of the great difficulty which the surgeon must experience in any attempt to cast a ligature around it.   In order to expose the artery, the anterior border of the sterno-mastoid muscle must be taken as a guide to the knife, and an incision made from three to five inches in length, an abundance of room being indispensably necessary to success.   Two ligatures are required—one above and the other below the seat of injury—when the vessel is secured on account of hemorrhage, or for the cure of traumatic aneurism.   This fact, long ago pointed out by Guthrie, was strikingly illustrated in the case of Professor Briggs, of Nashville, in which the artery was tied in 1871, for aneurism, and in that of Professor H. B. Sands, of New York, in which it was ligated in 1872, on account of secondary hemorrhage, consequent upon the extirpation of the lower jaw.   In both of these examples, as well as in every other, so far as I have been able to ascertain, in which the common carotid artery was secured for the suppression of hemorrhage of the internal carotid, the

patients perished from loss of blood. When the artery is ligated on account of hemorrhage from the ear, the tonsil, or epithelioma of the throat, as in the cases reported, respectively, by Billroth, A. Smith, and Von Langenbeck, only one ligature will be required.

The case of Professor Briggs was one of traumatic aneurism in a man twenty-three years of age, the result of a stab received six weeks before. The tumor, which was as large as an ordinary fist, and occupied the left parotid region, was laid very freely open, the clots turned out, and the artery tied above and below the wound, the common carotid having been previously secured without any effect upon the hemorrhage. In Professor Sands's case, the internal carotid artery gave way ten days after disarticulation of the left half of the lower jaw, performed on account of malignant disease in a man fifty-three years of age. Two ligatures were applied, one on the proximal and the other on the distal side of the ulcer in the vessel, and immediately after a ligature, previously placed around the common carotid artery, was tightened. All bleeding now ceased. The two ligatures around the internal carotid separated on the ninth day, and that on the common carotid on the fourteenth day, followed by complete recovery.

The ligation of this vessel may be greatly facilitated, especially as has been suggested by Guthrie, when it has been wounded through the mouth, by severing the lower jaw at the second molar tooth. By drawing the posterior fragment outward, increased space will be obtained which will be of material assistance in the efforts necessary to pass and tie the ligature. In performing any operation upon this vessel, the surgeon must be in full possession of a knowledge of the anatomy of this part of the neck, otherwise his efforts will be sure to eventuate in disappointment, if not in discomfiture and disgrace.

The statistics of this operation are very unsatisfactory. Wyeth has found only 19 cases, and in only two of these was the internal carotid alone tied. In 6 cases, the common carotid was tied at the same time, with 3 cures and 3 deaths; in 3 the external, all being successful; and in 6 cases the common, external and internal, 3 recovering and 3 dying. In one instance, the internal carotid and internal jugular vein were tied, the result being favorable, and in another case, equally successful, the three carotids and internal jugular vein were ligated. The operation in 14 cases was performed for hemorrhage, of which 5 died; in one, for aneurism, followed by recovery, and in a fatal one for an erectile tumor. The 2 cases in which the internal carotid alone was ligated recovered.

LIGATION OF THE SUBCLAVIAN AND ITS BRANCHES.

The point which is usually selected for tying the subclavian artery is just external to the scalene muscle, in what is considered as the third course of the vessel, excellent illustrations of which are afforded by fig. 346, from Bryant, and fig. 349, from Erichsen. One single incision will generally be found to be sufficient for the free exposure of the artery, and this may be strictly horizontal or more or less curvilinear, according to the fancy of the operator. It is only when the tumor is so bulky as to cause great malposition of the shoulder, forcing the collar-bone high up into the neck, that two incisions can really be required, the one extending along the upper border of the clavicle, and the other vertically upwards, parallel with the outer edge of the sterno-cleido-mastoid muscle.

Fig. 349.

Diagram of Right Subclavian Artery in Third Part of its Course, crossed by transverse cervical artery and vein. *a*. Subclavian artery. *v*. External jugular receiving the transverse cervical veins. *n*. Brachial plexus of nerves. *m*. Omohyoid muscle.

The patient, in this operation, rests in the horizontal position upon a narrow table, with his head and chest moderately elevated, and the face slightly inclined towards the sound side. An assistant taking hold of the hand keeps the affected limb close to the trunk, at the same time that he pulls down the shoulder as much as possible, in order to draw the clavicle away from the subclavian artery as it passes from the scalene muscle towards the first rib. The surgeon, standing by the side of the patient, above the shoulder, stretches the integument of the neck upon the upper part of the chest with the fingers of the left hand, while with the other he makes an incision, about two inches and a half in length, directly along the middle of the clavicle, commencing at the sternal origin of the mastoid muscle and terminating near the anterior margin of the trapezius. In this manner he divides the skin, superficial fascia, and platysma-myoid. Letting go his hold with his left hand, the parts will be found instantly to resume their natural

situation, leaving thus the incision on a level with the superior border of the clavicle. The next step of the operation consists in detaching from this bone the deep cervical aponeurosis, which may readily be accomplished by a few gentle strokes of the handle of the scalpel instead of the point of the instrument, which would greatly endanger the surrounding vessels and nerves. The external jugular vein will be found close to the outer edge of the mastoid muscle, and should be held out of the way with a blunt hook. The suprascapular artery will also generally appear, at this stage of the procedure, just above and behind the clavicle, or partially covered by it, and should be treated in a similar manner; or, if divided, it should immediately be tied. The omo-hyoid lies at the outside of the incision, bound down by a process of the cervical aponeurosis, which should next be torn through with the knife. Taking the anterior scalene muscle for his guide, the operator feels for the tubercle of the first rib, a little to the outside of which the artery will be found pulsating, more or less distinctly, and where it may generally be easily secured by passing the needle from before backwards and from below upwards. Previously to tightening the ligature, it should be ascertained that it controls the circulation in the aneurismal sac, and, above all, that it does not include any of the cords of the axillary plexus of nerves, a circumstance which has happened in several of the cases in which this operation has been performed. When the clavicular origin of the sterno-mastoid muscle is unusually broad, as it not unfrequently is, it should be divided upon the grooved director, as this will greatly facilitate the approach to the vessel, particularly when the design is to apply the ligature behind the scalene muscle.

In this manner, the subclavian may generally be easily reached without much loss of blood or waste of time. In some instances, however, the operation is rendered extremely difficult, tedious, and embarrassing, owing either to the magnitude of the tumor and the consequent elevation of the clavicle, the diseased state of the artery, the unusual course of the vessels of the neck, or even when these follow their natural direction, the swollen and distended condition of the subclavian vein, the irregularity of the omo-hyoid muscle, the enlarged condition of the cervical lymphatic glands, the great condensation of the parts from the effusion of plastic matter, or, finally, the upward extension of the pleura.

1. The *elevation of the clavicle* is generally in direct proportion to the size of the tumor. Sometimes, however, even when the swelling is comparatively diminutive, this bone is situated much higher up than usual, owing to the peculiar conformation of the individual. In either case, the difficulty of finding the vessel will be much increased. In one instance, in which the elevation was produced by the enormous development of the disease, Sir Astley Cooper was forced to abandon the operation altogether. When such a contingency arises, which, on the whole, must be extremely rare, instead of giving up the case in despair, as was done by the English surgeon, the best plan, it seems to me, would be to divide the anterior scalene muscle, so as to enable us to apply the ligature somewhat nearer to the heart, or even on the tracheal side of that muscle.

2. The operation is occasionally rendered more or less intricate and embarrassing by the *diseased state of the artery*. In this case, although the vessel may be easily enough approached, it is impossible to apply the ligature at the usual situation. To divide the scalene muscle, or to cut down along its margin, for the purpose of securing the vessel at one or other of these points, is here our only resource. The brachial plexus of nerves may also be so much in the way of the operator as to render this course necessary, as happened on one occasion to Dupuytren.

3. The *cervical vessels*, both arterial and venous, are almost constantly in the way of the operator, even when they pursue their usual route. This is particularly true of the external jugular vein and of the suprascapular artery. The former of these vessels, commencing at the angle of the jaw, passes vertically down the neck under cover of the platysma-myoid. In the early stage of its course, it rests upon the sterno-mastoid; afterwards it gets to the outer border of this muscle, and, finally, at the inferior part of the neck, sinks behind it, to terminate in the subclavian vein near its junction with the internal jugular. Just before it disembogues, which it sometimes does by several distinct trunks, it receives two pretty large branches, the suprascapular and transverse cervical, which traverse the neck in a horizontal direction from without inwards, parallel with the arteries of that name. These arteries, as well as their accompanying veins, lie deeply at the root of the neck, especially the suprascapular, which is frequently concealed for some distance by the clavicle, on a line with which it runs to reach the root of the coracoid process; it is generally a branch of the thyroid axis, and rests at first upon the anterior scalene muscle, crossing as it passes outwards the subclavian artery. The course of the transverse cervical artery is nearly similar, but it is usually situated somewhat higher up;

it is also considerably smaller, and is not unfrequently derived immediately from the subclavian.

Now, in attempting to reach the subclavian, it is almost impossible to avoid wounding some of the vessels above mentioned. The external jugular vein is particularly in danger, and can scarcely escape without the utmost coolness and dexterity on the part of the operator. As soon as it is recognized, it should be separated from the surrounding structures by a few gentle strokes with the handle of the scalpel, and drawn to the outer side of the wound. This plan is undoubtedly always the best and safest when it can be adopted; sometimes, however, it happens that the vessel is so much in our way as not only greatly to embarrass our progress, but absolutely put a stop to it. In this case it must be tied with two fine ligatures, and then divided. Such a procedure not only prevents hemorrhage, but also the introduction of air into the lower portion of the vessel, an occurrence which cannot be too carefully guarded against. The suprascapular artery, if in the way, should be drawn aside, or, if it be wounded, immediately secured. Any bleeding vessels, indeed, no matter whether arterial or venous, provided they pour out a sufficient amount of blood to interfere with the operation, should at once be tied.

4. The inordinate *swelling of the subclavian vein* is another source of embarrassment occasionally experienced in operations of this kind. This vessel is usually situated somewhat below and superficially to the artery, being separated from it by the anterior scalene muscle, upon which it lies. Commencing at the inferior margin of the first rib, where it is continuous with the axillary, it passes horizontally inwards until it joins the internal jugular vein, within a few lines of the sterno-clavicular articulation. In this course, in which it is almost entirely concealed by the clavicle, it receives the small branches which accompany the different offsets of the artery as well as the external jugular, which last enters it, as before stated, nearly opposite the centre of the bone, but sometimes more internally. After the division of the cervical aponeurosis in the lower part of the neck, the operator will occasionally observe this vessel alternately to swell and subside, owing not so much, as some have supposed, to the natural flow of the current within it as to the reflux caused by the action of the right auricle of the heart, aided by the hurried and agitated state of the respiratory movements. The difficulty thus occasioned is not only annoying, but sometimes so embarrassing as to render it almost impossible even to see the artery, much less to separate and tie it. To remedy this, it has been suggested that the operation should be suspended for a moment, and the patient placed in the semierect posture, to allow him to make several full and easy inspirations, after which, it is said, the tension of the vein will be diminished, and the regurgitation of the blood cease. The surest and most expeditious plan, however, is to hold the vessel out of the way by means of a broad, blunt hook, or copper spatula, carried down behind the clavicle. In this manner the vein may be effectually compressed to the extent of half an inch, or more, if necessary, and the artery fairly brought into view.

5. The *omo-hyoid* muscle, instead of forming a triangular space, as it usually does, with the scalene muscle and the clavicle, may run parallel with, and just above, that bone, or even entirely below it. In either case, should it be productive of inconvenience to the operator, he should pass a director under and divide it. Such a procedure, however, can seldom be called for, as, by laying open its sheath, the muscle may generally be drawn out of our reach.

6. The *lymphatic glands*, at the inferior part of the neck, may be so much enlarged as to interfere seriously with the different stages of the operation. When this is found to be the case, instead of trying to save these bodies, they should be carefully dissected out, as we shall thus not only expedite our arrival at the artery, but, what is a matter of no little importance, greatly facilitate the healing of the parts after the vessel is tied.

7. Considerable embarrassment may arise from the *condensed and indurated* state of the parts, caused by an effusion of plastic matter. This may always be looked for when the disease is of long standing, or when the tumor is so large as to excite severe inflammation in the deep-seated structures immediately above the clavicle, thereby obscuring the nerves and vessels.

Finally, the position of the *pleura* above the clavicle often presents a very serious impediment to the ligation of the subclavian. The extent of this projection varies, on an average, from an inch and nearly a half to two inches, and sometimes even exceeds the latter measurement. What adds to the embarrassment, especially when the aneurism is very large, is the fact that the artery in the third part of its course runs for some distance in close contact with the pleura, which, in the effort at detaching the vessel, thus incurs great risk of being penetrated, as has, indeed, happened in a considerable number

of cases. The late Dr. Isaacs, of New York, ascertained that the top of the pleura, or that portion which projects above the clavicle, is not always dome-shaped, but that it occasionally forms cul-de-sacs, extending upwards, and sometimes even laterally into the very recesses at the root of the neck.

If, from any of the above causes, it is sometimes difficult to denude the artery, to convey a ligature around it will often be found to be much more so. Indeed, this generally constitutes the most annoying and embarrassing step of the operation. To facilitate this procedure, various mechanical contrivances have been resorted to, some of them so complicated in their character as to be well calculated to enhance instead of diminishing the difficulty. Under ordinary circumstances every indication may be fulfilled with the common aneurism-needle, or even with a common eyed-probe. Whatever mechanical contrivance be employed, the ligature, as a general rule, should be passed from before backwards and from below upwards, as it will be found much easier in this way to prevent injury to the subclavian vein, while there will be no danger whatever of including any of the cords of the brachial plexus of nerves. Owing to the great depth of the wound, not a little difficulty is sometimes experienced in tightening the knot. In this case the ingenious instrument invented by Dr. Hosack, of New York, will be found very useful. By holding the first knot firm, it enables the surgeon to tie a second or third with the utmost facility.

Notwithstanding the assistance to be derived from the different instruments that have been invented for that purpose, such has been the difficulty, in some instances, of conveying the ligature around the artery as to lead not only to great delay, but almost to an abandonment of the operation. It has been suggested under these circumstances, to saw through the clavicle, a proposal to which I can see no objection, provided the shoulder is so much elevated as to offer an almost insurmountable barrier to the passage of the ligature. By this practice, although a compound fracture of the clavicle would be superadded, yet this would be of the most simple kind, while the operation, instead of occupying from one to two hours, as has repeatedly happened heretofore, could be completed in a comparatively short time; the vessel could be much more effectually secured, the risk of wounding the subclavian vein and other important structures would be greatly diminished, and the patient would have a much better chance for recovery.

The great embarrassment that is occasionally experienced in tying the subclavian artery for axillary aneurism, is well illustrated in a case that occurred in the hands of Dupuytren, in which that celebrated surgeon spent an hour and forty-eight minutes in performing the operation, a part of the time, however, being wasted in consequence of the suffering of the patient. The man died of hemorrhage at the end of four days, when it was found that the ligature included one of the large brachial nerves and only half of the artery, which had been perforated with the aneurismal needle. Ramsden tied one of the brachial nerves instead of the artery; White included three nerves in his ligature, and Desault the greater portion of the brachial plexus. The pleura has been repeatedly wounded, and in several cases the aneurismal sac has been penetrated. The subclavian and jugular veins are liable to be injured in attempts to secure this artery.

The subclavian, instead of pursuing its usual course, occasionally passes in front of the anterior scalene muscle, its situation being thus rendered comparatively superficial. Of this anomaly, I have witnessed not less than five examples in dried preparations. Occasionally, again, the artery, on the right side, is situated considerably higher up than usual, arising, not from the innominate, but from a short, stunted trunk in common with the right carotid; while in other cases, it takes its origin from the arch of the aorta, and passes behind the œsophagus, lying deeply in the neck, so as to render it difficult to find it, as in the celebrated case of Mr. Liston.

The arteries which are more particularly concerned in maintaining the collateral circulation after the ligation of this vessel are the suprascapular, transverse cervical, internal mammary, long thoracic, circumflex, and subscapular, the first three being branches of the subclavian, the other three of the axillary. The thoracic artery frequently arises from the aneurismal sac, and is, therefore, liable to be obliterated for some distance in the progress of the disease.

The subclavian artery has been tied several times in the second course of its extent, but the procedure is very difficult, as well as replete with danger, owing to the proximity of numerous important structures, especially the phrenic nerve, jugular vein, pleura, and thyroid axis. The external incisions are similar to those employed for exposing the artery in the other parts of its extent; as soon as the anterior scalene muscle is fully brought into view, a grooved director is carried behind it, and its lower attachment carefully severed from the first rib, the phrenic nerve having previously been placed beyond

the reach of the knife. The top of the pleura, lying close by, must not be wounded in passing the needle. It will thus be perceived that the operation is one of excessive delicacy, requiring consummate anatomical knowledge and skill for its successful execution. The greatest objection, however, to its performance is that the subclavian is obliged to be tied so close to the superior intercostal and deep cervical branches; a circumstance which must necessarily materially interfere with, if not wholly prevent, the formation of a firm and adherent clot.

The manner of exposing and ligating this artery in the first part of its course need not be pointed out, since, from the fact that all the cases in which the operation has been performed have ended fatally, it is questionable whether it should ever be repeated.

Among the most elaborate statistics of ligation of the subclavian artery are those contributed to the eighteenth volume of the Transactions of the American Medical Association by Professor Willard Parker, of New York. They comprise 196 cases, of which 88 were cured, and 107 died, the result in one not being stated. Of 153 cases in which the sex is given, 138 were males and 15 females. The right artery was tied in 82, and the left in 52 cases, in which the side is noticed. The average date of separation of the ligature was the 21st day. In the first portion of its course, it was ligated 13 times, without a single recovery; in the second portion of its course 9 times, with 4 deaths, and in the third portion of its course 174 times, with 89 deaths. In their point of order, the most frequent causes of death were hemorrhage, exhaustion, pyemia, pleurisy, and rupture of the sac. The artery was ligated 57 times, with 21 deaths, for spontaneous axillary aneurism; 24 times, with 8 deaths, for traumatic axillary aneurism; 24 times, with 15 deaths, for spontaneous subclavian aneurism; 5 times, with 3 deaths, for traumatic subclavian aneurism; and 8 times, with 6 deaths, for aneurism of the innominate artery. In the remaining cases the subclavian artery was ligated for other causes than aneurism.

In the collection of Dr. Koch are comprised 185 cases of ligation of the subclavian in the third portion of its course, for all causes. Of these, 100 died, 82 recovered, and in 3 the result is not stated. Ligature between the scalene muscles was practised in 12 cases, of which 7 recovered; in 9 of the operations, for aneurism, and in 3 for other causes.

Dr. Wyeth's tables, published in 1877, embrace an analysis of 283 cases of ligature of the subclavian artery, all, excepting 32, relating to the third surgical division of its course. The sex is given in 262 cases, of which 240 occurred in males, and only 22 in females. The right side was affected in 132 cases, and the left in 90 of the 222 cases in which these particulars are stated. The greatest number of the cases occurred from the twentieth to the fortieth year. Of the 283 cases affecting the three surgical divisions of the artery, 162, or 57 per cent., proved fatal. Hemorrhage after the operation was noticed in 93 cases, in 47 of which it proved fatal. In the majority of cases, in which the fact is stated, the ligature came away between the eleventh and twenty-first days; in one as early as the seventh day, and in one as late as the ninety-sixth day. Of 19 cases in which the subclavian was tied in its first course not one recovered. Of these cases 13 were for ligature of the subclavian alone, and 6 of this artery and the carotid on the right side. In 8 of the fatal cases the cause of death was hemorrhage. From these facts it is evident that, as stated by me in former editions of this work, ligation of this portion of the artery for aneurism on the distal side of the ligature is not a safe or proper operation. Ligation of the subclavian in the second part of its surgical course, behind the scalene muscle, presents 13 cases, of which 4 completely recovered, and 9, or 69 per cent., perished. Of the former cases, in one—that of Morton—gangrene seized on the extremity, and death was averted by amputation at the shoulder-joint. Of ligation of the artery in its third division, that is, from the outer border of the anterior scalene muscle to the lower border of the first rib, the tables give 251 cases, of which 134, or 53 per cent., were lost. Of the 117 recoveries, the great majority were complete. In gunshot and other wounds of the subclavian artery, considered as a whole, the only safe procedure is ligation of the injured vessel at both ends. Experience has proved that, if the artery be tied in its continuity, death from hemorrhage is inevitable.

In a case reported in 1868, by Mr. Turner, of Brighton, that gentleman tied successfully both subclavian arteries, at an interval of two years, for axillary aneurism.

The subclavian is occasionally tied for wounds of the axillary artery. Mr. Guthrie refers to 22 cases in which it was secured for this purpose, 11 times above the clavicle, and 11 times below. Of the former cases, 9 recovered, and two died; death in one being caused by the bursting of an internal aneurism, and in the other by gangrene after

amputation at the shoulder-joint. Of the 11 cases in which the artery was tied below the clavicle, 6 recovered, and 5 perished, three from gangrene of the limb, one from exhaustion, and one from hemorrhage. During our late war this vessel was secured above the clavicle, for a similar object, 17 times, with 2 recoveries ; 13 times after amputation at the shoulder-joint, of which 9 perished ; and twice, with one cure, for secondary bleeding after excision of the humerus. Of 66 cases of ligation of the third portion of the subclavian for hemorrhage from gunshot and other wounds, analyzed by Dr. Wyeth, 19 recovered, and 47 died.

LIGATION OF THE VERTEBRAL.

The vertebral artery is usually the first largest branch of the subclavian, and always bleeds profusely when divided, as it occasionally is in wounds of the neck. Taking the opening as the guide, the vessel should be traced to the seat of injury, and a ligature applied to each extremity. The dissection necessary for its exposure should be conducted with the greatest caution, on account of the important and complex relations which the vertebral sustains to the surrounding parts. The best guide to the seat of the vessel is the transverse process of the sixth cervical vertebra, situated about two inches above the clavicle, and usually known as the carotid tubercle. The artery will be found just below this prominence, deep in the wound, and at the inner side of the anterior scalene muscle.

A case has been reported by Maisonneuve in which he tied successfully the vertebral artery, together with the inferior thyroid, below the sixth cervical vertebra, on account of a gunshot wound. He carried his incision along the anterior edge of the sterno-cleido-mastoid muscle, and exposed the sheath of the common carotid artery, which was then carefully held aside while he denuded and secured the injured vessels. Nuntianti Ippolito has related two cases in which the vertebral artery was successfully tied at its origin. Dr. Smyth, of New Orleans, successfully tied this vessel for secondary hemorrhage after ligation of the innominate and carotid ; and Professor Parker secured it simultaneously with the carotid and subclavian for subclavian aneurism, but the patient died of hemorrhage. Dr. Alexander, of Liverpool, has recently recorded six successful examples of ligation of the left vertebral artery for epilepsy, in one of which the common carotid was simultaneously tied, and in another the internal carotid was consecutively ligated.

When the vertebral artery is laid open in such a manner as to render its ligation impracticable, the hemorrhage may sometimes be promptly and effectually arrested by means of a graduated compress, as in an interesting case treated by Professor Warren Stone, of New Orleans.

LIGATION OF THE INTERNAL MAMMARY.

No instance has been reported, so far as I am aware, of spontaneous aneurism of this artery, but of the traumatic form of the lesion an example has been related by Demontègre as having occurred in a man seventy-six years of age, from the thrust of a sabre. The tumor was two inches in length.

The internal mammary artery is sometimes cut across in gunshot injuries, and it is not unlikely that it might be opened in a bad fracture of the sternum and of the ribs. However this may be, the proper way to secure it, in the event of hemorrhage, is to follow the track of the wound, enlarging it freely, if necessary. The artery with its two veins will be found, in the early part of its course, about three lines from the edge of the sternum, in front of the triangular muscle, which separates it from the pleura. It may readily be reached in the three upper intercostal spaces by a vertical incision, two inches and a half in length, carried in the direction just indicated, successively through the superficial fascia, skin, pectoral, and intercostal muscles ; the deep structures must be divided with great care upon a grooved director, and the artery cautiously separated from its satellite veins. The pleura must not be interfered with. Below these points the operation will be very difficult, if not impracticable, on account of the great narrowness of the intercostal spaces. In case of emergency, the only feasible plan would be to cut away one of the costal cartilages.

LIGATION OF THE INFERIOR THYROID.

The inferior thyroid has been repeatedly tied for hemorrhage and for the cure of goitre. In wounds of the neck, involving this vessel, the ligation is, in general, easily effected simply by enlarging the existing opening in the direction of the part whence the blood issues ; but when there is no such guide, the operation is usually one of considerable difficulty, requiring nice anatomical knowledge and careful dissection.

The inferior thyroid artery, in the first part of its course, ascends a little, and then inclines inwards, passing behind the great vessels and nerves of the neck. The easiest way of exposing it, when there is no wound, is to make an incision along the inner border of the sterno-cleido-mastoid muscle, as in the operation for tying the primitive carotid, the sheath of which should be drawn carefully outwards. The artery will be found to cross over towards the thyroid gland, opposite, in most cases, to the fifth cervical vertebra, and may readily be encircled with a common aneurism-needle. Care must be taken not to injure the sympathetic, recurrent, and hypoglossal nerves. On the left side the artery lies in close contact with the œsophagus and thoracic duct.

LIGATION OF THE AXILLARY.

Deligation of the axillary artery was first performed by Mr. Richard Chamberlaine, of Jamaica, in 1815. The operation is required chiefly on account of penetrating wounds of the chest, secondary hemorrhage after amputation at the shoulder-joint, or the accidental laceration of the vessel during the reduction of ancient dislocations. Of the latter occurrence, a number of cases have been reported by surgical writers. There are two regions where the artery may be secured, either just below the clavicle, or in the hollow of the axilla. In the intermediate point it is so deeply situated, and is in such intricate relations as to render its approach very difficult.

As the artery in the first of these regions is very deep-seated, it has been advised, instead of tying it, to ligate the subclavian in the third stage of its course. Cases, however, occur, in which it is desirable to secure it soon after its origin, and this may generally be done without any difficulty, provided the surgeon is sufficiently cool and collected, and has a thorough knowledge of the anatomy of the parts. The patient being placed in a half-sitting posture, with the arm slightly abducted, an incision is carried along the inferior border of the clavicle, through the skin and platysma-myoid, commencing one inch from the sternum, and extending to within a short distance of the deltoid muscle, care being taken to avoid the cephalic vein, as it lies in the groove between the latter and the great pectoral. The next step consists in dividing the fibres of the great pectoral to the full extent of the external wound. The small pectoral is now seen at the lower portion of the wound, and should be relaxed by bringing the arm close to the trunk. A retractor being inserted, and the divided structures well depressed, the artery will be found at a short distance below the clavicle invested by a dense fascia, which must be carefully scraped through before the vessel can be fairly exposed to view. The accompanying vein, which often swells suddenly out during expiration, lies below and in front of it, while the brachial plexus is behind, except one of its branches, which is above and in contact with it. The anterior thoracic

Fig. 350.

Diagram of Left Axillary below clavicle   a. Axillary artery giving off thoracico-acromial.   v. Axillary vein receiving the cephalic.   n. Brachial plexus of nerves. The great pectoral muscle is cut across.

artery, one of the offsets of the axillary, is also on its anterior surface. The needle is passed from within outwards, in order to exclude the vein. As difficulty is sometimes experienced in distinguishing the artery from the cords of the axillary plexus of nerves, it will be well, before tightening the thread, to ascertain what effect its application has upon the pulse at the wrist, or upon the aneurismal sac. The costo-coracoid ligament sometimes requires division in this operation. The anatomical relations of the artery are well shown in fig. 350, from Erichsen.

Instead of cutting through the substance of the great pectoral muscle, the artery may easily be exposed by carrying the incision along the groove between its two bellies, commencing about one inch external to the sterno-clavicular joint, and extending outwards

and downwards, for at least three inches and a half, in the direction of the insertion of the muscle. If, upon separating the two bellies, it be found that there is not sufficient room, the upper one should be divided perpendicularly as far as the collar-bone. The artery has sometimes been tied in the first part of its course, as in the cases of Desault and Roux, by simply separating the pectoral and deltoid muscles, without any division of their substance.

To expose the artery in its inferior section, fig. 351, from Bryant, the arm should be abducted and supinated, and an incision, nearly three inches in length, made through the

Fig. 351.

Ligation of the Axillary Artery.
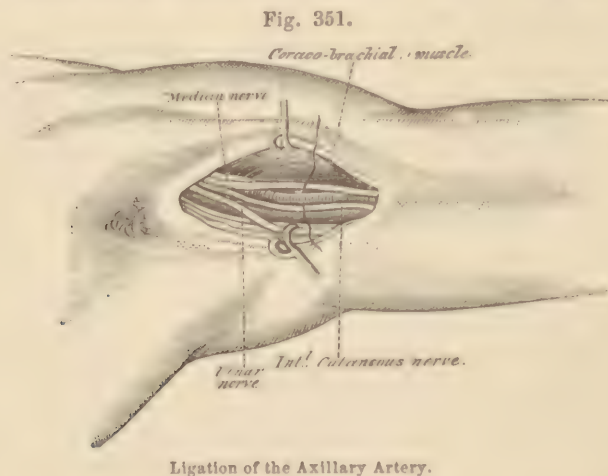
axilla, close to the border of the broad dorsal muscle. The connective and aponeurotic structures being next divided, the median nerve and axillary vein will be brought into view, the two roots of the former embracing the artery on each side, and the latter running along its anterior surface. Cautiously separating these with the finger, or the forceps and director, and turning them in opposite directions, the artery is exposed, and tied by passing the ligature from within outwards.

It is barely possible that the axillary artery might require ligation in its second course, as it lies under cover of the small pectoral muscle. If so, the muscle should be divided about three-quarters of an inch from its attachment to the coracoid process. The great objection to the operation is, not the depth of the artery in this situation, but the difficulty of separating it from the axillary plexus of nerves, and the close proximity of the ligature to the origin of the thoracic vessels, thus embarrassing the formation of a firm clot.

Of 15 cases of ligation of the axillary artery for gunshot wounds during the War of the Rebellion only 3 were successful.

LIGATION OF THE BRACHIAL.

The brachial artery, in consequence of wounds and various kinds of traumatic aneurisms, requires to be ligated more frequently than any other artery in the body. Extending from the lower border of the axilla, on a level with the tendon of the teres muscle, to nearly one inch below the bend of the elbow, it is overlapped above by the coraco-brachial muscle and in the middle by the two-headed flexor, while inferiorly it is completely covered by a reflexion of the brachial aponeurosis. Its whole course, however, is comparatively superficial, so that it is easy to feel its pulsations in the greater portion of its extent. In attempting to secure the artery high up, near its origin, an incision, two inches and a half in length, should be made along the inner margin of the coraco-brachial muscle, the limb being extended and supinated with the forearm in a state of partial flexion. The artery, accompanied by its two veins, lies here between the median and ulnar nerves, the former being on its outer side, and the latter on the inner. If the artery is sought for at the middle of the arm, the best guide to its seat will be the ulnar edge of the two-headed flexor muscle. The median nerve, in this part of the course of the artery, is usually on the inside and in front of the vessel, as in fig. 352, from Bryant. At the bend of the arm, the brachial is readily exposed by dividing the brachial aponeurosis in a line with the ulnar border of the tendon of the two-headed flexor muscle, as in fig. 353, also from Bryant. In none of these operations is it necessary to divide any muscular fibres.

In operating upon the brachial artery, it should be borne in mind that this vessel is subject to certain varieties, which may serve both to perplex the surgeon, and mar the result of the undertaking. The most frequent of these anomalies is the high division of

Fig. 352.

Ligation of Brachial Artery.
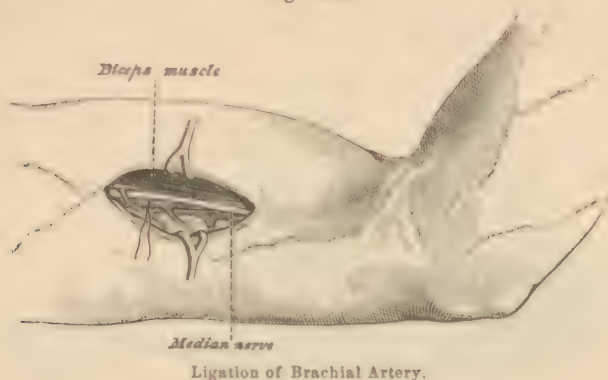
the artery into the radial and ulnar, which, on reaching the elbow, either pursue their usual course, or, as is more generally the case, the former proceeds superficially down the forearm, while the latter becomes deep-seated; or their course may be reversed, the radial following its ordinary route, while the ulnar descends immediately under the skin. Sev-

Fig. 353.

Ligation of Brachial Artery.
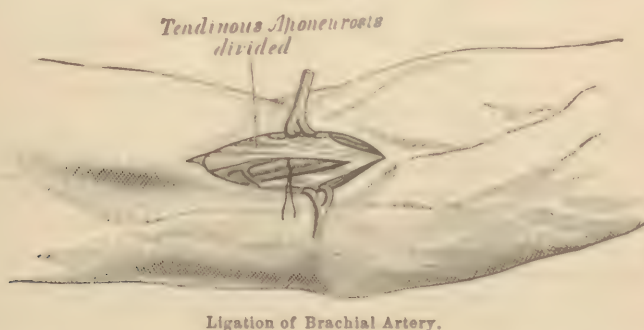
eral instances have been met with in which the brachial divided high up into two branches, which subsequently united into a single trunk, which afterwards bifurcated regularly into the radial and ulnar.

During the War of the Rebellion the brachial artery was ligated for hemorrhage consequent upon gunshot injuries 76 times, with a result of 55 recoveries and 21 deaths. In 9 cases consecutive amputation was practised, and only 3 recovered.

LIGATION OF THE RADIAL, ULNAR, AND PALMAR ARTERIES.

The radial artery, whose course along the forearm is indicated by a line drawn from the middle of the bend of the elbow to the forepart of the styloid process of the radius, may be tied near its origin, at its middle, and at its inferior extremity. When the design is to ligate it above, or in the first of these situations, it may be approached by an incision, about three inches in length, parallel to the inner border of the long supinator muscle, between which and the round pronator the vessel will be found, accompanied by its two veins, the radial branch of the musculo-spiral nerve lying at its outer side, and some distance from it. Care is taken not to wound the basilic vein. In the middle third of the forearm, the artery lies between the long supinator and flexor muscle of the carpus, the radial nerve descending close along its radial border, as in fig. 354, from Bryant. In the inferior portion of its extent, the artery is comparatively superficial; its pulsation is very distinct in the greater part of its length, and thereby serves as a ready guide to its course. The artery, as it lies upon the back of the carpus, underneath the tendons of the extensors

of the metacarpal bone and first phalanx of the thumb, is easily reached by an oblique, transverse, or longitudinal incision. It is accompanied by two veins.

The ulnar artery is sometimes divided in the upper part of its extent by a knife or ball, and may then generally be easily found by taking the wound as our guide, enlarging it, if necessary, and tying the vessel at each extremity. When a false aneurism exists in this situation, it is usually recommended to ligate the brachial, but I am satisfied that it

Fig. 354.

Supinator longus
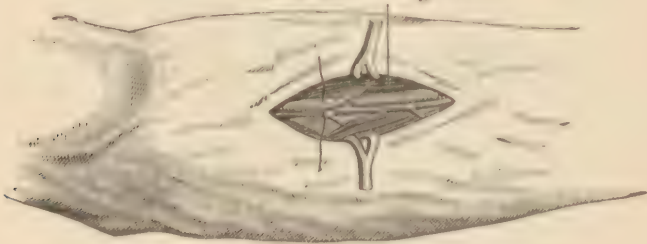
Ligation of Radial Artery.

would be more safe, in every instance, to tie the ulnar soon after its origin, by cutting boldly through the thick muscular mass at the upper third of the forearm, as we could thus effectually guard against hemorrhage from the recurrent circulation. In the middle of the limb the artery lies along the radial border of the ulnar flexor of the carpus, which should, therefore, be taken as a guide to the knife, and be carefully separated from the common flexor of the fingers. The ulnar nerve here lies on the inner side of the vessel. Near the wrist the artery is generally found with facility, its situation being indicated by its pulsation.

During the War of the Rebellion the ulnar artery was ligated 10 times, with 3 deaths, and the radial artery 20 times, with 4 deaths.

Ligation of the palmar arteries is rendered necessary in case of external injury, and can only be successfully effected by enlarging the wound freely upon a grooved director. This should always be done as early as possible, before the supervention of swelling, which greatly increases the difficulty. When the parts are much obscured, acupressure will sometimes arrest the bleeding more readily than the ligature.

The superficial palmar artery, forming what is called the palmar arch, is the continuation of the ulnar artery, and lies, at its commencement, on the annular ligament of the wrist, and then on the tendons of the superficial flexor of the fingers, in close relation with the divisions of the median and ulnar nerves. It is covered near the inner border of the hand by the short palmar muscle, and afterwards by the palmar aponeurosis and the integument. At the thumb it inosculates with a small branch of the radial artery. The deep palmar artery arises from the ulnar artery at the origin of the palmar arch, a little beyond the pisiform bone, and, passing forward under cover of the short flexor of the little finger, unites with the palmar termination of the radial artery, thereby completing, as stated by Quain and Sharpey, the deep palmar arch.

LIGATION OF THE ABDOMINAL AORTA.

Ligation of the abdominal aorta may be required on account of a wound, either of itself or of the common iliac, and in that event the best plan would probably be to enlarge the external opening to an extent sufficient to encircle the vessel with the thread. In ligating the vessel for aneurism, the patient should lie on his right side, and care should be taken to avoid injury to the peritoneum, which can easily be done by adopting the procedure of Dr. Murray, since followed by Monteiro and South, of making a curvilinear incision with the convexity towards the vertebræ, from an inch above the anterior superior spinous process of the ilium to the cartilage of the tenth rib, as in fig. 355, from Bryant. It should be fully six inches in length, and should extend, in the first instance, merely through the common integument. The various underlying structures should then be severally divided until the peritoneum is brought into view, which is cautiously peeled off from the iliac and psoas muscles with the hand a short distance beyond the contemplated point of ligation. The separation of the aorta from its accompanying vein on the right

side, and the filaments of the sympathetic nerve in front, constitutes one of the greatest difficulties of the operation, and is generally best effected with a long director, slightly

Fig. 355.
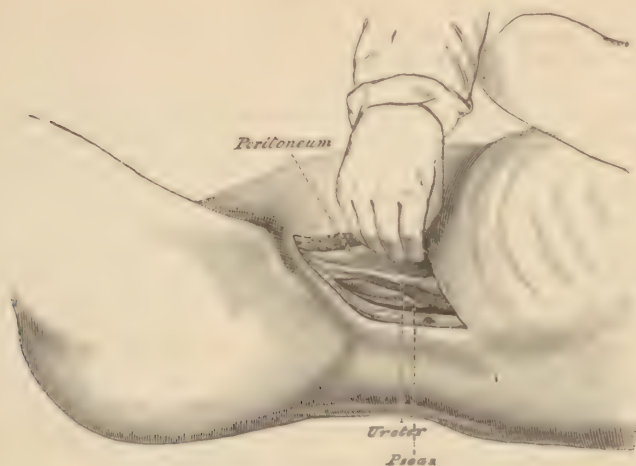
Ligation of the Aorta.

sharp at the extremity, and the nail of the index finger. The ligature should be passed around the artery from left to right, and from behind forwards, about one inch above its bifurcation into the common iliacs.

LIGATION OF THE COMMON ILIAC.

The common iliac artery was first ligated by Dr. William Gibson, of this city, in 1812, in a case of gunshot wound. His patient died in thirteen days, of peritonitis and secondary hemorrhage. In 1827 it was tied, for the first time, for aneurism, by Dr. Mott. The disease occupied the external iliac artery; the ligature came away on the nineteenth day; and in less than two months the man was entirely well.

This artery has been secured 65 times, with a result of 14 recoveries and 50 deaths, the issue in 1 being unknown; 36 of the operations were for aneurism, of which 10 were successful, and 25 died, the result being undetermined in 1; 16 were practised for hemorrhage, with 15 deaths; 4 were for malignant pulsating tumors, of which 3 died; 2 were for arterio-venous aneurism of the external iliac artery and vein, and both were fatal; 1 was for anastomotic aneurism, and the patient, a child six weeks old, recovered; and in 6 the nature of the disease is unknown, but 5 died. The mortality of the procedure, based upon 64 cases in which the result is known, is, therefore, 78.15 per cent. Three fatal cases occurred in the army during our late war.

Fig. 356.

Ligation of the common iliac, fig. 356, is far from being an easy operation, especially in case of aneurism, attended with a large tumor and morbid adhesions of the peritoneum. The patient lying on his back, with the thighs somewhat relaxed, a slightly curvilinear incision is made along the lower part of the abdomen, about half an inch above Poupart's ligament, commencing at the external ring and passing upwards and outwards a short distance beyond the anterior superior spinous process of the ilium, its length varying from five to seven inches, according to the exigencies of the particular case. The operator should, in every instance, give himself an abundance of room. The first cut extends merely through the skin and superficial fascia. The other

Ligation of the Common Iliac.

structures, beginning with the aponeurosis of the external oblique muscle, are then sever-
ally divided upon the director down to the peritoneum, more and more caution being
observed in proportion as we approach the deeper parts. The serous membrane is now
gently and slowly detached, by means of the finger, from the aneurism and other textures,
as high up as the necessities of the case may demand. The artery being thus denuded,
is next isolated from the accompanying vein, and the thread deposited by passing the
needle from within outwards, above the middle of the vessel. The different steps of the
operation will be greatly facilitated if the patient has previously taken an active cathartic,
to unload the bowels. Care must be employed not to wound the spermatic cord.

From numerous trials upon the dead subject, Dr. Stephen Smith advises, as the easiest
and safest method of approaching the vessel, that an incision be made extending from near
the anterior extremity of the eleventh rib to within a few lines of the internal ring, with
a sharp curve inward of one inch. It will thus pass about an inch and a half within the
anterior superior spinous process of the ilium, and be about seven inches in length. The
curve at the lower extremity of the wound will allow the most perfect freedom in the
elevation of the peritoneum, and the complete exposure of the artery.

In a case reported by Professor Sands, of New York, in 1881, the incisions were made
directly down to the artery, through the peritoneum in the linea alba. The operation,
which was performed with the carbolized catgut ligature under antiseptic precautions, was
followed by gangrene of the foot and leg, requiring subsequent amputation of the thigh.
Notwithstanding these untoward occurrences, the intemperate habits of the patient and
a syphilitic taint of the system, complete recovery took place.

The primitive iliac arteries extend from the cartilage between the fourth and fifth
vertebræ to the sacro-iliac symphyses, diverging from each other as they descend at a
somewhat acute angle, their point of commencement being nearly one inch and a half
below the umbilicus. Each rests on the spine and psoas muscle, and is crossed anteriorly,
at its bifurcation, by the ureter. On the right side, the accompanying vein lies, above,
behind and external to it, while, lower down, a portion of the vein appears on the inner
side; on the left side, the vein passes along the inner side of the artery, both vessels being
placed under cover of the sigmoid flexure of the colon. The course of the artery is indi-
cated by a line extending from the umbilicus to Poupart's ligament, a little nearer to the
pubes than to the ilium.

The length of the common iliac artery is generally about two inches, from which it
varies from less than twelve lines as the minimum to three inches and a half as the
maximum, depending, as has been shown by Mr. Luther Holden, either upon a high
division of the aorta, or a low division of the common iliac, or both. It is often short in
tall men, and conversely. Both vessels are usually of the same length.

LIGATION OF THE INTERNAL ILIAC.

The ligation of the internal iliac has now been practised twenty-six times, the operators
having been Altmüller, Arendt, Atkinson, Bigelow, Cianflone, Coluzzi, Galozzi, Higgin-
son, Kasinski, Kimball, Landi, McKee, McLean, Morton, V. Mott, A. B. Mott, Oeverent,
Porta, Stevens, Syme, Thomas, Thompson, Torracchi, Tripler, and White, the remaining
case having occurred in Bellevue Hospital. It was first performed by Dr. Stevens, of St.
Croix, in 1812, upon a negress, for what was supposed to be an aneurism of the gluteal
artery, but which was found, on dissection, three years afterwards, to have arisen from
the sciatic. The tumor had originated spontaneously, and was, at the time of the opera-
tion, of the volume of a child's head. Of the 26 cases, 8 terminated successfully, and 18
fatally, a result which need not create surprise when we take into consideration the great
depth at which this vessel is situated, the injury that must necessarily be inflicted upon
the surrounding parts in exposing it, and the exceedingly unfavorable character of most
of the cases themselves prior to the operation. The artery, moreover, is very short and
disproportionately large, being generally less than two inches in length; it is, besides,
in intimate relation with various important structures, thus rendering it extremely difficult
of access. Thus, it lies on the internal iliac vein, which, however, on the right side,
projects from underneath it over its outer edge; it is crossed above by the ureter, and is
overhung by the bladder, while that on the left side lies immediately behind the rectum.
Close by are the sacro-lumbar and obturator nerves, the latter, along with the external
iliac vein, running in the angle which separates the internal from the external iliac artery.

The manner of exposing the artery is the same as in ligating the common iliac. Dr.

White, of Hudson, who tied this vessel successfully in 1827, for gluteal aneurism, made a semicircular incision on the side of the abdomen, with its convexity to the ilium, seven inches in length, commencing two inches to the left of the umbilicus, and terminating close to the external ring. It is not necessary, however, I conceive, to carry the incision so far inwards, as the object may be just as well attained by the other procedure, and with less risk of bad consequences. The peritoneum is carefully raised with the fingers, and it is worthy of notice that the membrane, as it is being peeled off, invariably carries with it the ureter, thus placing this duct completely beyond the reach of the ligature. The fascia investing the artery is scraped away with the nail or handle of the scalpel, and, taking the precaution of avoiding the external iliac vein, as it lies in the angle between the internal and external iliac arteries, the surgeon deposits the ligature by passing the needle from within outwards.

When the internal iliac artery is very short, or the pelvis unusually small, so as to render the ligation of the vessel very difficult, it would be more prudent to secure the common trunk ; the procedure would be attended with less violence to the parts, and with less risk of peritonitis and secondary hemorrhage.

The most common cause of death after this operation is secondary hemorrhage, of which one of the patients perished within the first twelve hours. In Mott's case, a successful one, the peritoneum was opened. One of the difficulties of this operation, is the separation of the iliac artery from its accompanying vein. The circulation, after the application of the ligature, is carried on mainly by the lumbar and sacro-lateral branches.

LIGATION OF THE GLUTEAL.

The gluteal artery has been repeatedly ligated on account of hemorrhage and traumatic aneurism, as, for example, in the famous case of Mr. John Bell, where, to use his own hyperbolical language, the incision was upwards of a foot and a half in length. In exposing the vessel for the relief of hemorrhage, the surgeon is necessarily obliged to take the external wound as his guide, enlarging it, if possible, in the direction of the muscular fibres, and giving himself an abundance of room, especially if the artery is divided just as it emerges from the sacro-sciatic notch. It must be remembered that the vessel is accompanied by a vein and nerve, which must be carefully excluded from the ligature. If the artery is cut off close, it may be necessary to pass the thread with a curved needle, and to include in the noose some of the surrounding tissues, as it will probably be impracticable to raise it with the tenaculum.

In case of traumatic aneurism of this artery, most writers recommend the ligation of the internal iliac ; but, when we remember the difficulties and dangers of this operation, and the probable occurrence of peritoneal inflammation and of secondary hemorrhage, it seems to me that it would be better, in every respect, to cut down upon and tie the gluteal itself. The operation, will, of course, be bloody and formidable, but skill, boldness, and promptness may accomplish much, even in a case like this, especially when everything is well ordered beforehand, and the assistants are properly instructed in their respective duties. The incision, made in the direction of a line extending from the posterior superior spinous process of the ilium to a point midway between the tuberosity of the ischium and the great trochanter, must be at least eight inches in length, and should be carried at one stroke down into the aneurismal sac, the contents of which should then be turned out, and the artery instantly secured, as it lies towards the upper part of the wound.

When ligation is impracticable, on account of the great shortness of the artery, the hemorrhage may sometimes be effectually arrested by means of a graduated compress, thrust into the bottom of the wound, previously cleared of clots, and firmly bound down by a roller carried around the thigh and pelvis.

In a case of traumatic aneurism of the gluteal artery, in a boy, fourteen years of age, Professor Campbell, of Montreal, in 1862, secured this vessel at the upper and anterior portion of the sciatic notch, without opening the tumor. Some difficulty was experienced in passing the ligature, but as soon as this was tied all pulsation in the sac ceased, and a rapid recovery was the consequence.

In 1834, Mr. Richard Carmichael, of Dublin, reported a case of wound of the gluteal artery in a youth, seventeen years of age, in which he made an incision, five inches in length, into the sac of the aneurism, turned out from one to two pounds of coagulated blood, and ligated the vessel, the patient making a rapid recovery. In a similar case, Mr. Syme, after having evacuated the contents of the tumor, passed a double thread under the artery, and tied it on both sides of the wound, the bleeding of which was effectually

controlled by the pressure of the finger. The operation was completely successful. In 1877, Mr. Edward L. Hussey, of Oxford, tied the large descending branch of the gluteal artery on account of an aneurism, the result of a punctured wound. The sac was laid open by a large incision. Death occurred on the sixteenth day from secondary hemorrhage. Of five cases of ligation of the gluteal artery for hemorrhage during the War of the Rebellion, two recovered, and three died.

LIGATION OF THE SCIATIC.

The sciatic artery is also liable to be injured, either by sharp-pointed bodies penetrating the gluteal region, or by falls upon the buttock in which the vessel is laid open by a splinter of bone around which it passes as it proceeds forwards. It is situated under the great gluteal muscle, at first posterior and then internal to the great sciatic nerve, and winds around the spinous process of the ischium, near its root, behind the muscles which are inserted into the intertrochanteric line of the femur. It may be exposed by making a similar incision, as in the preceding case, but about an inch and a quarter lower down. When the operator is in doubt as to which artery is implicated, whether the sciatic or gluteal, the incision should be made as nearly as possible in the intermediate space.

The sciatic artery has been tied, in at least one instance, for an aneurism seated upon its own trunk, Dr. Dugas, of Georgia, being the operator. Owing, however, to secondary hemorrhage, caused, apparently, by the patient's own imprudence, the common iliac had to be secured at the end of a week, when the man was almost moribund from the loss of blood. Death occurred four days afterwards. Both of the cases in which this vessel was tied, during our late war, died.

LIGATION OF THE EXTERNAL ILIAC.

Ligation of the external iliac artery was first practised by Mr. Abernethy, in 1796, in a case of aneurism of the femoral artery, which he had previously tied at the distal side of the tumor; but severe hemorrhage coming on some time after, he found it necessary to apply a ligature above the swelling. The operation, however, failed; and it was not until 1806, after two other attempts, that his efforts were finally crowned with success. In this country it was first performed by Dr. Dorsey, of this city, in 1811, in a case of inguinal aneurism.

Fig. 357.
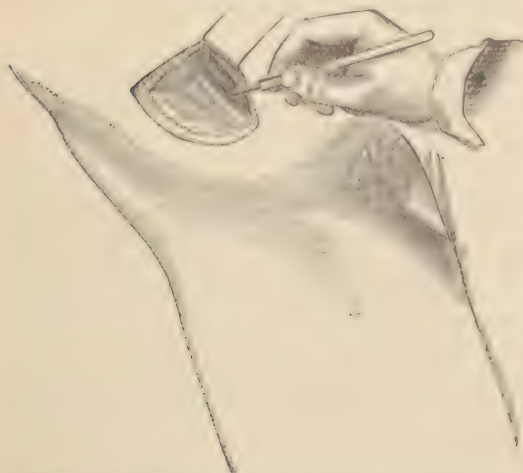
Ligation of the External Iliac by Abernethy's Operation, modified.

There are several methods in vogue for exposing this artery and encircling it with a ligature, each of which has its advantages and disadvantages, although the results have perhaps not essentially varied in any. That of Abernethy, slightly modified, shown in fig. 357, from Erichsen, is, perhaps, the most unexceptionable. It consists in making a curvilinear incision, with the convexity downwards, along the inferior portion of the abdomen, commencing about an inch and a half above Poupart's ligament, just outside of the external ring, and terminating on a level with the anterior superior spine of the ilium, about two inches on the inner side of this process. Its length should be from three inches and a half to four inches, according to the size of the tumor and the stature of the patient. The first cut, extending through the skin and superficial fascia, will probably sever a few little arteries that should be tied before proceeding any further. The aponeurosis of the external oblique muscle is now in sight, and should be divided upon the director. Then comes the internal oblique muscle, next the transverse muscle, and, finally, the transverse fascia, readily recognized by its opaque, whitish appearance. A small hole having been scratched into this membrane with the nail or scalpel, it is slit open to the full extent of the outer

wound.   The next step, and one of the most delicate of all, consists in gently and cautiously detaching the peritoneum from its connections in the iliac fossa; an operation which is often attended with considerable difficulty on account of the morbid adhesions.   The iliac artery will now be felt pulsating at the bottom of the wound, having the anterior femoral nerve at its outer side and on a somewhat deeper plane, and the iliac vein at first behind, but afterwards, near Poupart's ligament, internal to it.   The sheath of the artery is now carefully penetrated, when the instrument bearing the ligature is gradually insinuated around the vessel from its inner side, this procedure being found best to avoid injury to the vein.   The course of the artery is indicated by a line extending from the umbilicus to a point midway between the pubic symphysis and the anterior superior spinous process of the ilium.

Arendt has placed upon record a case in which he successfully tied both the external iliacs in the same patient after an interval of only eight days.   In a similar case in the hands of Mr. Tait, of London, the interval was upwards of eleven months; and in another, in the practice of Dr. Watson, of Glasgow, the interval was nearly nine months.   Mr. Newbiggin, in a remarkable instance, by tying the external iliac artery, cured both an inguinal and a popliteal aneurism at the same time.

There are several circumstances worthy of attention in connection with the ligation of the external iliac.   In the first place, the ligature should, if possible, be placed around the vessel about its middle, which will be nearly two inches above Poupart's ligament, the artery being usually from three inches and a half to four inches in length.   If the ligature is applied low down, near to the origin of the epigastric artery, there may not be sufficient room for the formation of a coagulum, and the patient may perish of secondary hemorrhage, as happened in a case recorded by Béclard.

Secondly, if the transverse fascia be not properly divided there will be danger in peeling off the peritoneum of detaching the iliac fascia along with it, and so dragging the artery out of its normal position to such an extent as to cause, perhaps, serious embarrassment in finding it.

Thirdly, care must be taken not to wound the peritoneum.   I have witnessed several instances in which it was separated with immense difficulty, on account of the great firmness with which it adhered to the aneurismal sac, from the effects of plastic deposits.   In a case of Dr. Wright Post, of New York, the membrane was so much thickened and altered by disease that he found it impossible to detach it, and was consequently obliged to make an opening into it in order to admit the ligature.   Both in this case and in one in the practice of Mr. Tait, the patient recovered.

Fourthly, no little difficulty is occasionally experienced in separating the artery from its accompanying vein, owing to their naturally firm union, which is often greatly increased by disease.   The object is most easily attained with a grooved director slightly sharpened at the extremity.   In passing the ligature, care must be taken not to include the genital branch of the femoral nerve.

Fifthly, should the external iliac be found to be too much diseased, or the tumor so large as to overlap the greater portion of the artery, as it may when the sac extends upwards beneath Poupart's ligament, it will be easy to ligate the common trunk simply by enlarging the wound, especially at its upper angle.

Sixthly, the manipulations will be greatly facilitated if the patient's bladder and bowels are well evacuated a short time previously to the operation.

Seventhly, the ligation of this artery is sometimes rendered very difficult on account of the presence of an inguinal hernia, as in a case in the practice of Mr. Morgan, of London.   Should such a contingency arise, unusual caution must be exercised, otherwise the bowel may be opened.

Lastly, the wound made in the operation should in this, as in the ligation of the other pelvic arteries, be sewed up carefully from the bottom, by carrying the needle close down to the peritoneum; in other words, the muscular and integumental lips should be tacked together separately, the object being the production of firm union, so that there may be no risk of hernia when the patient begins to set up and walk about.

The tables of Dr. Norris and Dr. Cutter show that this vessel has been tied for all causes 155 times, with 47 deaths, 17 having perished of gangrene, 3 of sloughing of the sac, 9 of hemorrhage, 5 of peritonitis, 3 of exhaustion, 2 of tetanus, and the remainder of various other affections.   During our late war our army surgeons had 16 deligations of this artery, with only 2 recoveries.

This artery is sometimes tied on account of external injury.   The operation, however, is seldom successful, owing to the violence inflicted upon the peritoneum.   In a case of

wound from an accidental stab, in a lad seventeen years of age, the bleeding was temporarily arrested by compresses, until Velpeau placed a ligature around the vessel. The patient made a speedy recovery.

After the ligation of the external iliac, the collateral circulation is maintained chiefly by the anastomosing branches of the gluteal, sciatic, obturator, and pudic arteries with the circumflex and deep branches of the femoral.

LIGATION OF THE EPIGASTRIC.

The epigastric artery is occasionally wounded, either accidentally or in operating for hernia, tapping the abdomen, or ligating the iliac. The vessel, although small, may give rise to fatal hemorrhage, the more readily as the bleeding is generally insidious and deep-seated, and it should, therefore, be secured without delay. To do this, an incision, about two inches in length, is made just above, and parallel to, Poupart's ligament, in a line corresponding with its centre, cautiously dividing the parts until the artery is reached, as it lies between the transverse fascia and peritoneum. It is accompanied by two veins, which must be carefully excluded from the ligature. The artery arises on the inner side of the external iliac, about three lines above Poupart's ligament, and ascends inwards just within the inner border of the internal ring, where the deferent duct hooks around it on its way to the inguinal canal. Should the vessel be cut off close to the external iliac, it might become necessary to cast the thread round this artery instead of the epigastric.

LIGATION OF THE CIRCUMFLEX ILIAC.

The circumflex iliac artery, given off by the external iliac, usually a little lower than the epigastric, is sometimes wounded, and may, from its large size, cause embarrassing, if not fatal, hemorrhage. It may be secured, in the first part of its course, in the same manner, very nearly, as the epigastric, the incision being made close to, and parallel with, Poupart's ligament, its centre being opposite the internal ring. Further out, it may be exposed by dividing the tendon of the external oblique muscle within half an inch of the margin of the ilium, where it is firmly bound down by the transverse fascia.

LIGATION OF THE COMMON FEMORAL.

The common femoral artery begins on a level with Poupart's ligament, and terminates from an inch and a half to two inches below in the superficial and deep femoral, the former being its direct continuation. The vessel, in all this course, is perfectly superficial, being covered merely by the skin, fascia, and aponeurosis; it is involved, however, in a number of lymphatic glands, which, when enlarged, may receive the pulsation of the artery, and so simulate aneurism. The femoral vein lies on the inside of the vessel, in the same sheath, and great care is required in separating it previously to passing the ligature. The femoral nerve lies external to the artery, and is, therefore, not endangered in the operation. Exposure of the artery is easily effected here by a vertical incision two and a half to three inches in length. The aneurismal needle should be conveyed from within outwards. The saphenous vein, which lies in close proximity to the artery, must not be wounded.

The late Professor W. H. Porter, of Dublin, who secured this vessel three times, made an oblique incision instead of a vertical one, six lines below and parallel with Poupart's ligament, its length being about one inch and three-quarters. Although the operation, when thus performed, is sufficiently easy, I should give a decided preference to the vertical incision, as it admits of more ready access to the artery, as well as of its more easy separation from the accompanying vein, especially in the event of any considerable enlargement of the lymphatic glands.

Great objection has been urged against the ligation of this vessel, in any portion of its course, on account of the liability of the operation to be followed by secondary hemorrhage, it being alleged that no permanent clot can form above the site of the ligature, in consequence of the close proximity of the epigastric and circumflex iliac arteries. One writer, Mr. Erichsen, indeed, declares that the operation should be banished from surgery. Others, on the contrary, assert that there are cases in which it may be very proper, an opinion with which my own views entirely coincide. When secondary hemorrhage arises, it will generally be found that it is due rather to a diseased condition of the coats of the vessel than to the vicinity of large collateral branches. Mr. Porter tied the common

carotid artery within a quarter of an inch of the innominate, and the patient recovered. Mr. Key successfully ligatured the subclavian artery close to the deep cervical; Dr. Bellingham, of Dublin, with an equally fortunate result, tied the external iliac near its root, on account of an aneurism of this vessel; and in his case of deligation of the common femoral, Mr. Oliver Pemberton cast the thread just above the origin of the profunda, the artery, notwithstanding this, being firmly plugged above and below. His patient, moreover, was generally diseased, and sixty years of age. Other cases, of a similar character, might be adduced, but these are quite sufficient to prove that the immediate vicinity of a large collateral vessel is no hindrance to the formation of a solid, substantial clot after the application of a ligature, provided the artery is free from disease, as chronic inflammation, and calcareous, fatty, or amyloid degeneration. I have myself in one instance succeeded in obtaining a firm clot in less than forty-eight hours after the application of a ligature to the femoral artery according to the method originally practised by Mr. Porter, the pressure being taken off completely by the end of that period. In a case in which I exposed the vessel by a vertical incision, fatal hemorrhage set in at the end of the ninth day, owing to a diseased condition of the artery, no protective coagulum having formed.

The number of cases in which this artery has been ligated for aneurism is, so far as I have been able to ascertain, eight, with a mortality of only two, or 25 per cent., a result that ought to satisfy the most exacting statistician. The case of Mr. Collis, usually quoted as one of deligation of the common femoral, is excluded from the accompanying table, since it was not an example of the operation at all, the ligature having been placed just below the profunda, which was given off high up, and the patient dying of secondary hemorrhage. Excluding the case of Mr. Gelston and my last case, in both of which the artery was extensively diseased, it will be perceived that the operation was uniformly successful when the artery was sound. It is true, in two instances, secondary hemorrhage supervened, but it was easily commanded by pressure, while the bleeding in the fatal cases was so alarming as to require deligation of the external iliac in one and acupressure of that vessel in the other. The common femoral trunk has been ligatured several times on account of external injury or for hemorrhage after amputation of the thigh, but the results have not been gratifying.

Date.	Operator.	Disease.	Result.	Remarks.
1848	W. H. Porter	Popliteal aneurism	Recovery	
1849	W. H. Porter	Femoral aneurism	Recovery	
1850	G. H. Porter	Femoro-popliteal aneurism	Recovery	Hemorrhage on 25th day, or five days after separation of ligature, commanded by slight pressure.
1860	J. Smyly	Popliteal aneurism	Recovery	Slight hemorrhage on 11th day, or four days before separation of ligature, easily controlled by pressure.
1868	T. G. Gelston	Femoro-popliteal aneurism	Died	Hemorrhage on 15th day, controlled by ligation of external iliac. Successive hemorrhages from old wound; death from pyemia and gangrene of foot and leg. Femoral artery extensively diseased at site of ligature.
1868	S. D. Gross	Femoral aneurism	Recovery	Pressure of ligature taken off in 48 hours.
1870	S. D. Gross	Aneurismal varix of femoral vessels of stump	Died	Hemorrhage on 6th day, from detachment of ligature, controlled by acupressure of external iliac and distal end of femoral. Patient never rallied. The femoral artery was much dilated and thinned.
1870	O. Pemberton	Femoral aneurism	Recovery	Ligature separated on 40th day. Death from inanition ten days subsequently.

In all the recorded cases in which this artery has been secured for aneurism, except in a single one by myself, the operator did not act from choice, but from necessity, the superficial femoral being inaccessible on account of the situation of the tumor. In the exceptional instance here referred to, the artery was included in a silver wire, loosened in less than forty-eight hours after its application, all pulsation in the aneurism having ceased before the expiration of that period.

LIGATION OF THE SUPERFICIAL FEMORAL.

Ligation of this artery is often necessary on account of wounds involving its continuity, and, until a comparatively recent period, it was almost exclusively practised for the cure of popliteal aneurism. If the artery is severed by a cut, or pierced by a sharp-pointed body, it is evident that it should be secured at the site of injury, the wound being, if necessary, enlarged, and a ligature applied to each extremity of the vessel.

In aneurism, the artery may be tied at two points of its extent, the superior and middle, the former being, however, by far the more eligible, as the vessel here is comparatively superficial, and, therefore, easy of access. Its course along the thigh is indicated by a line extending from a quarter of an inch within the centre of Poupart's ligament to the inner margin of the patella. In the upper third of the limb, it lies immediately beneath the skin and aponeurosis, its pulsation being easily felt as it runs along the inner margin of the sartorius muscle. This space is from four to five inches in length, and is of a triangular shape, its base being formed by Poupart's ligament above, and its apex by the convergence of the sartorius and adductor muscles below. The femoral vein descends along the inner border of the artery, and is inclosed in the same sheath; the connection between them is very firm and intimate, and it, therefore, requires great caution to effect their separation. The femoral nerve lies on the outside of the artery. It is worthy of remark that the moment a ligature is tightened around this artery in any portion of its course, the patient, unless fully anæsthetized, experiences great pain, not unfrequently accompanied by a sense of numbness and tingling in the limb. This effect is probably due to the inclusion of a minute nervous filament, and generally promptly disappears of its own accord.

Fig. 358.
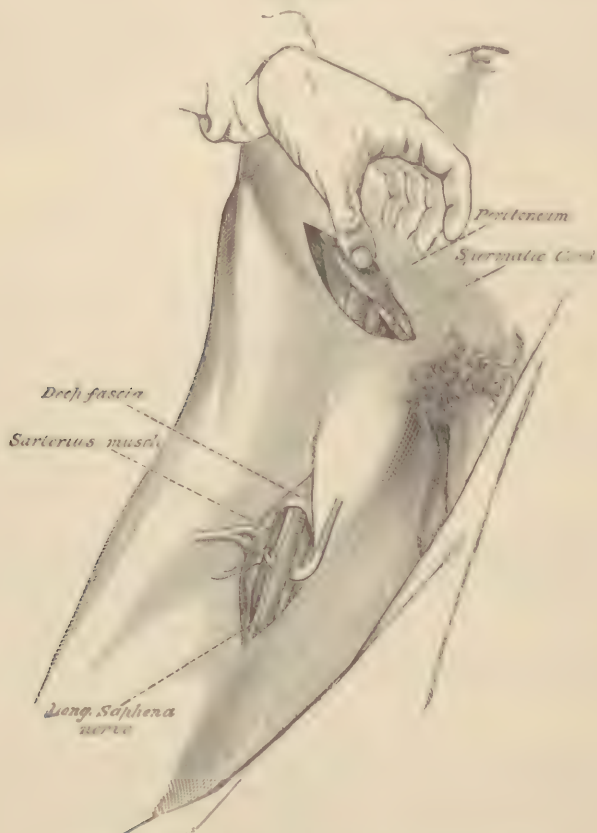
Ligation of External Iliac and Superficial Femoral Arteries.

To expose the artery in this part of its course, an incision should be made along the inner border of the sartorius muscle, beginning about two inches and a half below Poupart's ligament, and extending obliquely downwards to the inferior extremity of the

triangle through the skin and superficial fascia. A portion of the aponeurosis is now pinched up with the forceps, and a horizontal opening made into it barely large enough to admit the point of a grooved director, upon which the sheath of the vessel is carefully divided for about nine lines. The artery is separated from the vein in the usual manner, but with extreme caution, and the ligature passed from within outwards, close to the former vessel. Injury to the vein would be a serious calamity, as the patient might perish from phlebitis, or gangrene of the limb. The occurrence is usually denoted by a gush of black blood upon drawing out the thread. Pressure will readily arrest the flow, and the vessel must on no account be tied, as such a procedure would inevitably give rise to a bad form of suppuration, the ligature acting very much as a seton, exciting and keeping up morbid action. A little nerve occasionally runs down in front of the artery, and must be drawn out of the way.

The femoral artery, in its middle course, as seen in fig. 358, from Bryant, is deep-seated, lying under cover of the sartorius muscle, which must, consequently, be turned to one side in the act of exposing it. The corresponding vein will be found external to the artery. In some instances it is double, and then the artery runs between the two vessels, closely hugged by them; or one of the veins lies in front of the artery and the other in the usual position. In operating upon the superior portion of this space, just below the triangle above described, the incision should be made along the inner edge of the sartorius, which is then everted so as to afford free access to the vessel as it lies beneath the aponeurosis. If, on the other hand, the lower site be selected, the cut should be made on the outside of the muscle; but no one will be likely to do this if he can avoid it, as the operation will be both tedious and difficult, and possesses no advantage whatever over the more common procedure.

The femoral artery is subject to certain anomalies which should not be forgotten when we undertake its ligation, as they might seriously affect the result. The most important of these anomalies are the following:—First, the high division of the artery, the vessel separating a short distance below Poupart's ligament into two branches, which go to form the posterior tibial and peroneal. Secondly, the artery may be double, the supernumerary one giving off the branches usually furnished by the profunda. Thirdly, it may consist of two equal trunks which afterwards unite to form the popliteal. Sir Charles Bell found this curious anomaly in a negro upon whom he operated for popliteal aneurism, the two vessels coalescing as they entered the ham. In this case the blood in the sac had in a great measure coagulated, notwithstanding that the circulation through it had been maintained by the non-ligated artery. A similar instance occurred to Sir Astley Cooper. An abscess formed in the sac, after the detachment of the ligature, and the patient died of hemorrhage. The dissection showed that a large branch had been given off by the femoral artery above the point of ligation, and had again united with that vessel just before it terminated in the popliteal, thereby feeding the tumor, and preventing its obliteration. Mr. Fleming, of Dublin, in 1866, met with a case of double femoral artery, in which he was obliged to secure each vessel separately before any decided impression could be made upon the pulsation of the tumor, an aneurism of the popliteal artery. Matters progressed favorably for some time, when, suddenly, an abscess formed in the sac, necessitating amputation of the limb. Several examples of entire absence of the superficial femoral artery have been recorded, one, among others, by Mance, its place having been supplied by the sciatic, which passed down along the back of the limb to become the popliteal. The femoral vein is occasionally, although rarely, double.

One of the most serious accidents incident to ligation of the femoral artery, for the cure of aneurism, is the puncture of the femoral vein, especially liable to occur, if the greatest caution be not exercised, in the upper portion of the thigh, in consequence of the abnormal adhesions which occasionally form between the two vessels from inflammatory deposits caused by an extension of irritation from the tumor. The injury may be inflicted with the knife in the efforts to separate the two vessels, or with the aneurism needle in the act of passing the ligature. However this may be, the artery must at once be exposed either higher up or lower down, and the wound in the vein treated by compression, so as to convert it into one of a simple character. If, as when the vein is transfixed with the needle, the ligature be left in the vessel, it will inevitably act as a seton, lighting up diffuse phlebitis, speedily followed by the death of the patient. All such accidents are sure to end fatally; indeed, even the mere wounding of the femoral vein is always a very serious occurrence. It remains still an open question whether, when the vessel is merely pricked, it would not be perfectly safe to include the edges of the opening in a delicate

ligature, as has repeatedly been successfully done in perforation of other veins, provided the operation do not interrupt the current of blood in the injured vessel.

Another accident of a very embarrassing nature, and one which has occurred to me on two occasions, sometimes arises in ligating the femoral artery. I allude to a welling up of blood in the wound either before or after the ligature has been passed, evidently due to the division of a small anomalous branch, given off by the femoral, and unavoidably opened in separating the vessel from the surrounding structures. The bleeding is very embarrassing, the blood filling the wound as fast as it is sponged out; and in the two cases adverted to I was obliged to tie the main artery above and below the anomalous branch, inasmuch as it could not be included in a ligature.

The tables of Dr. Norris show that this artery has been tied for all causes 204 times, with 50 deaths, the mortality being about one in four.

Compression of the femoral artery is often necessary on account of hemorrhage, either of this vessel itself, or of some of its branches. It is also frequently employed for the purpose of controlling the circulation of the limb in amputations of the thigh and leg; and latterly it has been much resorted to for the cure of popliteal aneurism, having, in many cases, superseded the use of the ligature. When the object is to arrest the flow of blood, or stanch hemorrhage, the most suitable point for its application is the margin of the pubic bone, which is separated from the artery only by the pectineal muscle, and upon which, consequently, the pressure may be made with great efficiency. The best instrument for the purpose is the thumb of a stout assistant, or the handle of a large key, resting upon a small, thick pad. The more concentrated the pressure is, the more efficacious it will be in stopping the bleeding, and in preventing injury to the accompanying vein and nerves, circumstances that must not be overlooked in such a procedure. If the force be applied with the thumb, it may often be maintained, for several successive days by a relay of assistants, without detriment to the parts.

The other situations at which the artery may be compressed are the upper part of the thigh, just below Poupart's ligament, and those portions of the limb where the vessel may be pressed against the shaft of the femur, by directing the instrument outwards and backwards. When the compression is designed to be permanent, as in the treatment of popliteal aneurism, it should be frequently varied, making it now at this point, and then at that, as it may be painful or otherwise; and it is, moreover, of great importance, under these circumstances, that the instrument with which it is applied should not completely encircle the extremity, lest it impede the return of the blood in the veins, and thus occasion swelling and other mischief.

The principal agent in carrying on the collateral circulation after ligature of the femoral artery is the profunda, the branches of which soon become greatly enlarged, and by their anastomoses with the articular offsets of the popliteal artery, send the requisite supply of blood to the distal portion of the limb.

LIGATION OF THE DEEP FEMORAL.

The deep femoral artery has been known to be the seat of spontaneous aneurism, but the occurrence is extremely rare, and very difficult of diagnosis. The profound situation of the tumor, underneath the muscles at the anterior and inner part of the thigh, will usually serve to throw some light upon its character; but the only reliable sign is the continuance of pulsation, thrill, and bellows sound, and somewhat of an augmented intensity in the swelling when firm pressure is made upon the superficial femoral, about two inches below Poupart's ligament, so as to direct the blood with increased force into the deep vessel. The proper remedy, in such a case, as well as in traumatic aneurism, would be ligation either of the affected artery, or of the common femoral, an inch below its origin, where it may be felt beating immediately beneath the skin and aponeurosis. The application of the ligature to this vessel is sometimes required on account of hemorrhage.

The deep femoral is usually given off by the common femoral, from an inch and a half to two inches below Poupart's ligament; sometimes, however, it is detached considerably higher up, and occasionally it is furnished by the external iliac or by the femoral, immediately after the commencement of this vessel. The artery, soon after its origin, passes inwards, behind the superficial trunk, and gradually places itself under cover of the long adductor muscle, between which and the great adductor it afterwards descends towards the femur, near which it pierces the latter muscle, and finally disappears on the posterior part of the thigh. When this vessel is injured, the wound will, of course, serve as the readiest guide to it; and two ligatures will always be necessary to put an effectual stop

to the hemorrhage. In case of aneurism, the artery may easily be exposed, near its origin, by an incision similar to that made in ligating the common femoral, or the superficial femoral, in the superior portion of its extent, beginning an inch below Poupart's ligament, and descending obliquely in the direction of the inner border of the sartorius muscle. The deep trunk may then be readily traced to the requisite extent, and should be encircled a few lines below the origin of its two circumflex branches.

LIGATION OF THE POPLITEAL.

The popliteal artery, situated deeply in the cavity of the ham, in close relation with numerous important structures, is very difficult of access, especially in fat subjects. Fortunately it is seldom necessary to attempt its deligation, as wounds and traumatic aneurism here are of extremely infrequent occurrence. The artery is in intimate connection by its outer and posterior surface with the popliteal vein, from which it is not always easily detached. Sometimes the vein is double, and then the artery lies between the two trunks, closely and firmly embraced by them. The popliteal nerve is separated from the vessels by a thick layer of fat; superiorly it lies exterior to the artery, but as it descends towards the leg it gradually winds around it to place itself along its internal border.

There are two points at which the popliteal artery may be exposed for the application of the ligature; these are its superior third and its inferior third. The middle portion of the vessel is never interfered with, on account of its great depth, its near proximity to the knee-joint, the unyielding character of its lateral boundaries, and its intimate connection with the accompanying vein and nerve.

The artery may be ligated in the upper third of its extent, where it is more accessible than anywhere else, by carrying a vertical incision along the outer border of the semimembranous muscle, for about three inches, extending down as far as the popliteal nerve. The muscle is then drawn inwards and the nerve outwards, when, by the cautious use of the forceps and handle of the knife, the vein and artery will be easily found, and must be gently and carefully separated from each other, the needle being passed from without inwards.

Fig. 359.

Ligation of the Popliteal at its upper and lower parts. *a.* The Popliteal Vein. *b.* The Popliteal Artery. *c.* The Posterior Saphenous Vein The Popliteal Nerve, on the outside of the Artery, has been omitted in the Diagram.

Exposure of the artery, in the lower third of its extent, may be effected by a vertical incision between the heads of the gastrocnemial muscle. Care is taken not to injure the posterior saphenous vein and nerve, which lie close by, but to draw them, along with the popliteal nerve, away from the knife. The artery will be found to be deeply imbedded in the ham, partially concealed by the popliteal vein, but projecting somewhat to its outer side.

In his attempts to expose the popliteal artery, the surgeon must be careful not to make too free use of the knife, for fear of wounding the articular branches which are given off at a right angle, and which might, if injured, cause embarrassing hemorrhage.

This artery sometimes requires to be ligated on account of the subcutaneous rupture of its coats, as in a case reported by Mr. Poland. No difficulty was experienced in effecting the object, although much blood had been effused. The patient did well until the third day, when gangrene came on, followed by amputation and death. The ends of the artery, separated by an interval of an inch and a half in length, were each included in a ligature. In two other cases in which a double ligature was applied to this vessel, the result was also unfavorable.

LIGATION OF THE ANTERIOR TIBIAL.

The anterior tibial artery may require to be tied on account of hemorrhage or traumatic aneurism, and the best plan always is to take the external wound as a guide to the seat of the injury. The vessel, whose course is indicated by a line drawn from the head of the fibula to the base of the great toe, may be secured at three different points.

The artery, in the superior third of its extent, lies underneath and between the anterior tibial and common extensor muscles, and may be exposed by a vertical incision, four inches in length, carried down in the direction of the line just mentioned. The skin and

superficial fascia being divided, the aponeurosis is split open upon a director to the full extent of the outer wound; the two muscles are then separated from each other along their raphé, and the artery, which lies in close contact with the interosseous ligament, is surrounded with the ligature in such a manner as not to injure the accompanying veins. The anterior tibial nerve is exterior to the vessels.

In the middle third of the leg, the relations of the vessel are essentially the same as in the upper, except that the long extensor of the toe is interposed between the anterior tibial

Ligation of the Anterior Tibial at various parts. The Wounds are supposed to be held asunder. The Ligature is under the Vessel.

and common extensor. The artery is still deep-seated, and a long incision is required for its full exposure. A branch of the peroneal nerve sometimes attaches itself to the artery here, and must be drawn away before passing the ligature.

In the inferior third of the limb, the artery lies on the tibia, between the tendons of the common extensor of the foot and the proper extensor of the great toe, the latter overlapping it on the inside. The vessel here is, therefore, comparatively easy of access.

The *dorsal artery* of the foot, the continuation of the anterior tibial, is easily tied in any portion of its extent, as it runs down across the instep, its course being indicated by a line extending from the centre of the ankle-joint to the posterior extremity of the first interosseous space. It lies under cover of the integument and aponeurosis, and may readily be exposed by carrying the knife along the outer border of the tendon of the long extensor muscle of the great toe. The incision need not exceed one inch. The vessel is accompanied by a nerve and two veins.

LIGATION OF THE POSTERIOR TIBIAL.

The posterior tibial artery occasionally requires ligation on account of wounds and aneurisms of its own caliber, and, if the operation is performed high up, the task is one of the most arduous and perplexing that a surgeon can be called upon to execute. It has fallen to my lot to tie it in this situation in three instances, and the difficulties in two were very great, having been increased tenfold by the confused condition of the parts, in consequence of the large quantity of extravasated blood. In one of the cases the artery had been laid open by a pistol ball, and in the other by a dirk-knife: the hemorrhage was profuse, and could only be effectually controlled by the ligature. The third case was one of aneurism in the lower part of the vessel.

The situation of this artery is very deep; its course, at first obliquely inwards, and then vertical, is indicated by a line extending from the centre of the ham to the fossa between the heel-bone and the inner ankle. It is covered in the superior two-thirds of its extent by the gastrocnemial, soleal, and plantar muscles, but during the remaining portion it lies immediately below the integument, except at its commencement, where it is slightly overlapped by the tendo Achillis. It is accompanied and embraced by two veins, one being on each side of it. The attendant nerve lies internal to it in the upper part of the leg, but as it descends it crosses the artery superficially, and places itself along its outer margin. The posterior tibial artery is sometimes double, and cases occur in which it is unusually small, or even absent, its place being supplied by a large peroneal artery.

The artery may be exposed and tied in the upper and middle portions of its extent in one of two ways. The first consists in detaching the gastrocnemial muscle for about four inches along the inner border of the tibia, and cutting across the inner head of the soleal, by reflecting which we come directly down to the posterior layer of the aponeurosis of the leg, the free division of which brings the vessel at once fully into view. Care must be taken to avoid the internal saphenous vein, which runs close along the line of incision. The limb, during the operation, should rest upon its outer side, the leg being flexed at the knee, and the foot extended.

In the other method, originally suggested by Mr. Guthrie, the artery is laid bare by a long, vertical cut, extending through the centre of the muscles of the calf. Its advantages are, first, that the artery, being more directly approached, is more effectually under our control, and, secondly, that there is less danger of bagging, if blood and pus are poured out. The length of the incision need not exceed that in the other operation, and the hemorrhage is generally insignificant.

Fig. 361.

Of these two methods, I give a decided preference to that of Mr. Guthrie, who has justly stigmatized the other "as difficult, tedious, bloody, and dangerous." That it is so is fully confirmed by my own observation, in a case of circumscribed, traumatic aneurism of the lower portion of the tibial artery, in a man, between thirty-five and forty years of age, a patient at the College Clinic. Although I made a very long incision, and was ably assisted in the operation by Professor Wallace and others, such was the difficulty experienced in separating the artery from the concomitant veins, that, despite the utmost caution, one of the latter was wounded, followed by such an annoying hemorrhage that I was finally compelled to include the artery and the wounded vessel in the same ligature. The case went on well for a few days, when pyemia ensued, rapidly terminating in death.

In a case of pistol-shot wound of the posterior tibial artery, in a man, thirty-six years of age, I experienced no difficulty in finding and securing the vessel by what may be called the "direct method," so forcibly advocated by Mr. Guthrie. The incision required to expose the artery is, it is true, a long and deep one; but it has the advantage, and a very great one unquestionably it is, of affording more room, and of admitting of more thorough drainage.

Ligation of the Posterior Tibial, at various parts. The Wounds are held asunder, and the Ligature is under the Vessel.

The posterior tibial sometimes requires ligation in the lower portion of its extent, between the heel and ankle. Taking the pulsation for his guide, the surgeon makes an incision, about two inches in length, directly along its track, which is nearly midway between the two points here indicated. The direction of the incision should be somewhat curvilinear, with the concavity towards the inner malleolus. The artery here lies beneath three aponeurotic layers, which must be successively divided upon the director, when the needle is passed under the vessel from behind forwards, care being taken not to include the accompanying veins and nerve.

In consequence of the superficial situation of this artery in the lower portion of its extent, a convenient point is afforded between the inner malleolus and the tendo Achillis for the application of pressure in the treatment of hemorrhage of the sole of the foot. The effect may be greatly increased if the circulation is also arrested in the anterior tibial, as may readily be done by placing a compress over it, just above the joint. A bandage is then extended from the toes upwards as far as the ankle, around which it is to be passed in the form of the figure 8, until the bleeding is completely arrested. Sometimes a metallic arch may advantageously be stretched across the front of the joint, one end resting upon each compress, the object being to ward off injurious pressure.

Wounds of the arteries of the foot are often followed by troublesome hemorrhage, which may, eventually, lead to great, if not fatal, exhaustion. The cause of this is twofold, the deep situation of the plantar arteries, and their extensive and intricate anastomoses with each other. The general arrangement bears a very strong resemblance to that of the palmar arteries. It might be supposed, at first sight, that, when these vessels are wounded, the bleeding could readily be arrested by regular, steady, and systematic compression. This, however, is not the case. Why, then, not ligate them at once, without waiting until the patient is blanched and worn out by the loss of blood, in the vain hope that the operation may at length put a stop to it? That this is the proper course is unquestionable; hence the sooner it is carried into effect the better. The only objection to it is the large wound that is obliged to be made in order to expose the bleeding vessel; but this

must be done at all hazard, and a ligature applied to each extremity, lest the hemorrhage should continue through the recurrent circulation.

It has been proposed in these cases to cut down upon and tie the principal arteries of the leg, and we read of instances in which even the great trunk of the thigh was ligated for such a purpose. Such a procedure cannot be too strongly condemned, as being contrary both to common sense, anatomical knowledge, and sound experience. The experiment of tying both the tibial arteries has been tried again and again under such circumstances, and the almost invariable effect has been complete failure; as might, indeed, have been anticipated from a careful study of the disposition of the vessels of the foot.

Notwithstanding the somewhat pointed manner in which I have here spoken against compression in hemorrhage of the plantar arteries, it is but proper to add that I have seen this very method occasionally put a most prompt and effectual stop to the flow of blood. I recollect distinctly the case of a little girl, which came under my observation many years ago, where I succeeded, by a single dressing, in arresting an exhausting and daily recurring hemorrhage of upwards of a month's duration. A graduated compress placed over the orifice of the bleeding vessel, and confined by a roller extending from the toes upwards, aided by elevation of the leg and cold applications, constituted, as it always should when such a procedure is adopted, the means employed on the occasion.

Sometimes we may advantageously resort to the expedient of compressing the anterior and posterior tibial arteries by means of two corks, placed directly over these vessels, opposite the malleoli, and bound down firmly by a suitable bandage, passed around the foot and leg in the form of a figure 8. The corks should each be wrapped up in a bit of patent lint, and should be at least three-quarters of an inch in length, and of proportionate thickness and breadth, otherwise it will be difficult to make them retain their proper position. When the compression is obliged to be made with great firmness, it may be well, in order to defend the soft parts, to extend a piece of sheet lead across the limb under the bandage.

When the parts are so much inflamed and swollen as to render it difficult, if not impossible, to expose the affected vessel, the hemorrhage may sometimes be promptly arrested by acupressure, or by percutaneous ligation.

Venous hemorrhage, of an obstinate character, sometimes occurs in the foot, either as the result of accident, of amputation, or of the excision of a morbid growth, as a fibrous, fatty, or malignant tumor. The immediate cause of the trouble is generally a varicose and enlarged condition of the veins, the blood welling up from the bottom of the wound from numerous points. A tampon of cotton wet with a strong solution of subsulphate of iron, thrust firmly in contact with the bleeding vessels, covered with dry lint, usually arrests the flow in an instant; when this fails, the edges of the wound should be transfixed with a pin, and then drawn tightly together with a thread, as in the operation for harelip. In a case of Chopart's amputation of the foot, followed by profuse venous hemorrhage, in which all the more ordinary remedies had been fruitlessly tried, Dr. Beck, of Freiburg, promptly succeeded by ligating the posterior tibial artery three inches above the internal ankle. The veins were very numerous and extremely enlarged.

LIGATION OF THE PERONEAL.

The peroneal artery, after running a short distance, passes obliquely downwards and outwards to reach the fibula, along which it descends until it arrives near the outer malleolus, where it divides into its two terminal branches. It may be secured, in the upper portion of its extent, by making an incision, long and vertical, towards the fibular side of the leg, through the bellies of the gastrocnemial and soleal muscles; and inferiorly, as it lies between the outer malleolus and the tendo Achillis, by a cut at least two inches and a half in length, directed upwards and outwards towards the fibula. The vessel here rests upon the interosseous ligament, close to the inside of the bone, under cover of the long flexor of the great toe, which must be detached as far as it may be necessary from the bone, and drawn downwards.

CHAPTER VI.

INJURIES AND DISEASES OF THE VEINS.

The affections of the veins requiring to be noticed under this head are, wounds, hemorrhage, inflammation, varicosity, the formation of phlebolites, and the introduction of air.

SECT. I.—WOUNDS AND HEMORRHAGE.

Of wounds of the veins not much need here be said, as they rarely exhibit any difficulty in regard to their treatment, or much danger in respect to their termination. Like wounds of the arteries, they may be produced by various weapons, and are, therefore, distinguished by different names, as incised, punctured, lacerated, contused, and gunshot. They are always followed by more or less hemorrhage, according to the size of their caliber, the blood issuing from them in a continuous stream, of a dark, purple color. When the division is complete, there is hardly any retraction, or annular constriction, and hence the bleeding often progresses until it proves fatal, especially if the vessel is large and superficial, as in wounds of the jugular and femoral, fainting not materially favoring the formation of a clot. Partial wounds, of whatever direction, will also bleed copiously, if they are at all extensive, and no mechanical obstacle is offered to the flow of blood. If the incision is small, exhibiting the character of a puncture rather than of a cut, the bleeding, after having continued for some time, will gradually cease, in consequence of the formation of a minute, but gradually increasing, clot upon the edges of the wound. These phenomena may often be witnessed in ordinary venesection at the bend of the arm, the clot adverted to constituting one of the impediments to the flow of the blood, and occasionally compelling the operator to open another vein. In gunshot wounds, severing a large vein, the hemorrhage frequently proves as suddenly fatal, or nearly so, as in corresponding lesions of an artery; or, life being preserved by the narrow state of the wound, or the valve-like disposition of its walls, the blood may be extensively, and, perhaps, most prejudicially, infiltrated into the intermuscular and subcutaneous connective tissue.

The best examples of lacerated wounds of the veins are met with in those frightful accidents in which a limb is torn either partially or completely from the body. In such condition the hemorrhage is generally extremely small, perhaps hardly amounting to a few ounces; a circumstance due partly to paralysis of the vessels, and partly to the shreddy state of their tunics, together with the shock experienced by the system, the whole tending to the rapid coagulation of the blood, and the prevention of its further escape. This disposition is shared alike by the veins and arteries.

Spontaneous rupture of a vein sometimes occurs, as for example, of the external saphenous, from excessive distension of its weakened and attenuated coats, so frequent in varicose enlargement of this vessel. A similar accident may befall an internal vein. Contused and lacerated wounds of these vessels may be caused in various ways, one of the most common of which is the passage of a heavy vehicle over the body, or body and limbs. A case of rupture of the ascending cava, thus occasioned, has been reported by Piper. The vein was torn longitudinally near the auricle by the passage of the wheel of a gun-carriage over the chest.

Copious venous hemorrhage occasionally occurs after excision of different kinds of morbid growths, especially when they are seated upon the back or the side of the chest, parts in which the veins are either destitute of valves, or very imperfectly supplied with these important structures. I lately removed a sarcomatous tumor, the size of a double fist, from the inferior region of the scapula, in a man, thirty-eight years of age, in which I had an excellent illustration of this occurrence. Thirty hours after the operation, copious hemorrhage set in, the loss of blood amounting to at least a quart and a pint. Upon removing the stitches, and sponging away the clots, the most careful search failed to detect any bleeding vessel, or even the slightest oozing anywhere, thus conclusively showing, the more especially as there was no further trouble after-

wards, that the blood must have proceeded from valveless veins. Similar occurrences are occasionally witnessed in the stump, after amputation of the larger limbs, the blood issuing directly from the open mouths of the larger veins, in consequence of the deprivation of their valves from the manner in which the vessels are divided in the operation.

The chief danger from wounds of the veins arises from loss of blood, and inflammation of their tunics. The latter occurrence is occasionally observed as a consequence of the operation of bleeding at the arm with a foul or blunt lancet. Ordinarily, however, there is little risk of this kind, the parts readily uniting by adhesive action, since there is no impediment to this process from the sanguineous current, as there is, under similar circumstances, in an artery; all is calm and quiet within, and the most extensive wounds are often repaired in an almost incredibly short time.

The *treatment* of a wounded vein is generally very simple, merely by compress and bandage, and attention to position. If seated superficially, the mere contact of the edges of the breach generally promptly arrests the hemorrhage, without any direct application to the vein itself. In the operation of bleeding, the only dressing commonly employed, after the necessary quantity of blood has been evacuated, is a small pledget of muslin, placed immediately over the part, and confined by means of a roller. The slight inflammation that follows furnishes the requisite amount of plasma, and in less than twenty-four hours the union is generally so firm as to render it difficult to break it. When the divided vessel is deep-seated, as in wounds of the neck, axilla, groin, and thigh, and the bleeding cannot be arrested by compression, the only resource is the ligature, or, this failing, acupressure, applied in the same manner as in a bleeding artery.

A great dread of the ligature, as a hemostatic agent, in venous hemorrhage, until lately existed among surgeons. Convinced that this apprehension had been much exaggerated, Dr. S. W. Gross has examined the subject statistically, in an elaborate paper published in the American Journal of the Medical Sciences for January and April, 1867. Most of the cases tabulated by him refer to the internal jugular vein, wounded either accidentally, or in the removal of morbid growths. Of 43 cases, in which this vessel was tied, only 4 terminated fatally from the effects of the operation, the cause in all being secondary hemorrhage. In only one instance was there any evidence of pyemia; in none of diffused phlebitis. The average period at which the ligature separated was 13 days, the minimum 4, and the maximum 23. In the femoral vein, the detachment occurred, on an average, on the 11th day, in the axillary on the 9th, and in the external jugular on the 7th.

It will thus be seen that the danger of ligating veins is in great degree, if not entirely, unfounded. I have myself repeatedly tied the larger vessels of this kind, both in amputations and in the removal of tumors, with entire impunity, and the operation has often been practised, with equally happy results, by other surgeons. One important circumstance, upon which it is impossible to place too much stress, has been developed in the paper above alluded to, that the ligature should always be applied in such a manner as to effect complete occlusion of the vein. If any portion of its cavity be left open, there will be great danger of secondary hemorrhage, if not also of the entrance of air, pyemia, and diffused inflammation, owing to the insufficiency of the clots, and of the adhesions of the sides of the vessel.

The practice of applying a lateral ligature, as it is termed, when a vein is merely nicked, pierced, or partially divided, should be discarded, as the operation is almost invariably followed, on the detachment of the thread, by fatal hemorrhage, as will be perceived by a reference to the tabulated cases of Dr. S. W. Gross. In wounds of the internal jugular vein, fatal reflux bleeding will be likely to arise unless the vessel is tied at both ends.

Styptics are not suitable for the arrest of hemorrhage from a vein, unless the mouth of the vessel is previously occluded by a compress. Even the most innocuous article of this class, the subsulphate of iron, is dangerous, from the fact that it gives rise to the formation of large and numerous clots which afterwards become a source of irritation, liable to be followed by pyemia and diffusive erysipelas.

Tying the main artery of a limb for the arrest of venous hemorrhage has been practised successfully, in one instance, by Professor Langenbeck. The occasion for the operation was the removal of a large fibrous tumor of the thigh, in which the femoral vein was accidentally divided at Poupart's ligament. The bleeding was excessive, but ceased instantly upon ligating the already exposed femoral artery. The patient did well. A similar result, as is proved by cases quoted by Dr. Crisp, follows in

wounds of a vein made accidentally during the operation for popliteal aneurism. Langenbeck recommends ligation of the main artery of a limb whenever it is found that compression is of no avail in hemorrhage from large venous trunks. He thinks the simultaneous ligation of the principal vein improper, from its tendency to cause thrombus. Such practice should, in my opinion, be avoided; first, because to cut off the supply of blood suddenly from an extremity is attended with great risk of mortification; and, secondly, because I have never seen an instance in which venous hemorrhage could not be readily arrested by the compress or ligature. Acupressure has not been sufficiently tried as a means of checking venous hemorrhage. I have employed it in numerous cases with satisfactory results.

Rest is of great moment after wounds of the veins; it should be absolute, for the slightest motion may break up the adhesions, and endanger the part by inflammation. Exclusion of the air is also very desirable, and may be secured by compress and bandage alone, or by these means, aided by collodion.

SECT. II.—DISEASES OF THE VEINS.

Inflammation of the veins, technically called phlebitis, is occasionally an idiopathic affection; most commonly, however, it arises from injury inflicted either directly upon those vessels, or indirectly through other structures. It frequently follows upon severe accidents and surgical operations, and, when this is the case, it is apt to give rise to pyemia, or multiple abscess, a disease which, as stated elsewhere, nearly always proves fatal. Phlebitis is a much more common affection than arteritis, and differs from this lesion still further in its liability to terminate in suppuration, which arteritis seldom does, the ordinary product of the latter being plastic matter, not pus. Another peculiarity of phlebitis is its tendency to extend along the vessels towards the heart, thus greatly increasing its dangers. Recent researches, however, render it probable that this tendency is much less frequent than was formerly imagined. The affection is sometimes confined to one vein; but, in general, it involves a considerable number, either simultaneously or successively. In the former case it is said to be circumscribed; in the latter, diffused. Finally, it may be acute or chronic.

1. *Acute Phlebitis.*—The symptoms of acute phlebitis are not always well marked. When the affected vessels are superficial, their course is generally indicated by the existence of a corresponding number of red lines, which, on applying the finger, feel like hard, rigid cords, exquisitely sensitive to the touch, and reaching from the seat of the injury up the limb as far as the eye can follow them. The discoloration, which varies from a faint, rosy tint to deep red, or even purple, according to the intensity of the morbid action, gradually diffuses itself over the surrounding surface, and eventually exhibits all the characters which distinguish that of erysipelas. Considerable swelling usually attends, not unfrequently putting on pressure. The pain is of a sharp, smarting, or burning nature, and is generally so severe as to deprive the patient effectually of appetite and sleep.

Fig. 362.

Phlebitis; a Section of the Femoral Vein, occupied principally by Fibrinous Clots.

The constitution always deeply sympathizes in phlebitis, even when of comparatively limited extent. The disease is often, if not generally, ushered in by chilly sensations, if not actual rigors, alternating with flushes of heat; the pulse is frequent, quick, and irritable; the skin hot and dry; the stomach nauseated and otherwise disordered; the bowels costive; the urine scanty and high colored. If the patient was in ill health immediately prior to the attack, the symptoms will usually be of an adynamic character from the beginning; or, if not, they will soon become so. Excessive prostration, delirium, an icterode state of the countenance, gastric irritability, and great restlessness, are commonly prominent symptoms in every severe case of phlebitis.

The anatomical characters of acute phlebitis are swelling, opacity, and pulpiness of the internal membrane of the veins, with uniform redness, varying from light pink to deep florid. The middle and outer coats soon become profoundly injected, and their proper substance, although at first preternaturally soft and humid, is at length rendered so dense and firm that the vein feels like a hard, contracted cord. The cavity of the inflamed vessel is filled with clotted blood, as seen in fig. 362,

sometimes blended with pus or lymph, and in many cases it is lined by a false membrane, susceptible, under certain circumstances, of organization. Instances occur in which the pus is infiltrated into the substance of the vein, or collected into small abscesses beneath the serous lining. The pus of phlebitis is generally an imperfectly elaborated fluid, containing a large quantity of plastic matter, and comparatively few characteristic globules.

Acute phlebitis occasionally, but very rarely, passes into *ulceration*. The morbid action may either begin in the coats of the vessels, or it may be propogated to them during the progress of disease in the neighboring structures. Thus, in scarlatina, after the more immediate effects of the malady have disappeared, abscesses are liable to form in the neck and fauces, which have been known to communicate with the internal jugular vein, ending in copious, if not fatal, hemorrhage. The subjects of such occurrences are, for the most part, young children of a weak, cachectic constitution, and the danger is generally in proportion to their exhausted condition at the time of the accident.

Acute phlebitis is always a dangerous, and often a fatal, disease, few persons recovering when the morbid action is well established or extensively diffused. This remark is true both of the traumatic and idiopathic forms of the disease; also of external and internal phlebitis, or of inflammation of the superficial and deep-seated veins. The pus formed in the affected vessels, commingling with the blood, soon poisons the system, and thus renders the heart, brain, and spinal column unfit for the performance of their functions.

The *treatment* of phlebitis cannot be conducted with too much caution. When the disease is situated superficially, an attempt should be made, by leeches, blisters, iodine, and nitrate of silver, to circumscribe the morbid action, and thus prevent the formation of pus. Such a result, however, is not to be expected when the disease involves the internal or deeper veins, where the inflammation often makes great, if not irreparable, progress before the surgeon is aware of its true character, and where, consequently, treatment of every kind is of little or no avail. All lowering measures are generally inadmissible, even when the patient is comparatively young and plethoric; debility, great and marked, is sure to arise, and to call imperatively for the use of tonics and stimulants. Purgatives are exhibited to clear out the bowels and correct the secretions; and mercury is given in frequent and liberal doses with a view to early and decisive constitutional impression, the best form being calomel, or calomel and blue mass. The addition of morphia will be required for the threefold purpose of preventing undue purgation, allaying pain, and inducing sleep. The best stimulants are milk punch, quinine, and iron, especially the tincture of the chloride.

If abscesses form their contents must be evacuated by early and free incisions; the internal organs must be diligently watched, and any complications that may arise must be met by appropriate measures. The hemorrhage that follows ulceration must be arrested by compression and styptics.

2. *Chronic Affections.*—The characters of chronic inflammation of the veins differ considerably from those of the acute form. The coats of the vessels are usually so much thickened, hypertrophied, and indurated, as to preserve, when cut across, their cylindrical figure, like an artery. The redness is of a brownish tint, interspersed with numerous shades of gray, violet, or purple; and the inner membrane, rough and shrivelled, may easily be raised in large, opaque shreds. In some instances, the vein is dilated, or contracted, obstructed with clotted blood, lined by lymph, or filled with pus.

The disease sometimes passes into *ulceration*, but the occurrence is much less frequent than in the arteries. Commencing most commonly at one or more points of the inner membrane, it gradually extends to the other tunics, which it sometimes completely erodes. The immediate effect of this accident is an effusion of blood, which may be so great as to produce fatal results. The ulcers, which affect various forms, are occasionally quite numerous, and spread over a large extent of surface.

The veins are sometimes laid open during the progress of malignant disease, the ulceration extending from the exterior towards the interior. The hemorrhage caused in this way, especially when it proceeds from the larger veins, as the jugular or femoral, may be so great as to occasion death in a few minutes.

Chronic phlebitis is observed chiefly in the veins of the inferior extremity, and in those of the spermatic cord and of the ano-rectal region, as a complication of hemorrhoids. The principal symptoms are pains, of a sharp, pricking, or dull aching character, tenderness on pressure, and a sense of fulness or distension at the seat of the disease. The treatment is gently antiphlogistic, removal of the exciting cause constituting an object of primary importance.

There are certain states of the system in which the veins attain a very great size, and,

consequently, carry an inordinate amount of blood. This *hypertrophy*, for so it may be termed, is very conspicuous in chronic affections of the joints, and in various kinds of tumors, both vascular and malignant. It is always conjoined with hypertrophy of the arteries, and forms one of the most serious obstacles to the cure of certain diseases.

Obliteration of the veins is by no means uncommon, and is nearly always the result of inflammation. Sometimes it is caused by the pressure of a tumor forcing the sides of the vessel closely in contact, and so converting it into a dense, fibrous cord. The largest veins are sometimes thus obliterated. Such a condition is extremely liable to be followed by dropsical effusions and other ill effects inimical to health and life.

Loose concretions, *phlebolites*, or vein-stones, varying in size from a currant to a pea, are occasionally found in the interior of these tubes. Commonly of a yellowish, brownish, or bluish color, they are of a hard, brittle consistence, and of an oblong, oval, or spherical form, with a smooth, even surface. When divided, they are found to be made up of several thin but distinct lamellæ, disposed concentrically around a small delicate nucleus, frequently consisting of fibrin. The number of these concretions is extremely variable; occasionally as many as ten, twenty, or even thirty, are observed. They are generally met with in the smaller veins; more frequently, perhaps, in the spermatic, uterine, vaginal, vesical, hemorrhoidal, and splenic, than in any other. In the saphenous and its branches they often exist in connection with varicose enlargement. Their composition is principally phosphate and carbonate of lime, with a small amount of animal matter, probably albumen, and a trace of oxide of iron.

SECT. III.—VARIX.

A varicose and dilated state of the veins is by no means uncommon, especially in the lower classes of working people, and in mechanics whose avocation compels them to maintain habitually the erect posture. The veins which are most liable to suffer, in this respect, are those of the inferior extremity and of the spermatic cord, but those of the abdomen, scrotum, vulva, trunk, and face are also occasionally implicated, while those of the superior extremity are almost exempt from the disease. Nevertheless, an example of great enlargement occasionally occurs in them, as in a case recently under my observation in a man sixty-one years of age, in which the affection was complicated with varix of the corresponding shoulder and side of the chest. Of the deep-seated veins, those most frequently affected are the jugular, azygos, subclavian, and hemorrhoidal. I have met with a number of cases where there was apparently a varicose diathesis, almost all the principal veins in the body being abnormally tortuous and dilated.

Age exerts a remarkable predisposition to this disease. Thus, varicose enlargement of the spermatic veins is most common in young men soon after the period of puberty; while, in the inferior extremity, the greater number of cases occur after the thirtieth year. In the hemorrhoidal veins, the malady is most frequent in elderly subjects.

The veins, in this disease, are preternaturally large, tortuous, knotty, and convoluted, or as if they were folded upon themselves, being augmented both in diameter and length, and observing a singularly serpentine course, as they proceed to their place of destination. Their coats are hard, dense, and elastic, rolling under the finger like fine cords, with, here and there, a portion that retains its normal characters, or that is uncommonly thin and expanded, as if it were ready to give way under the slightest exertion. In cases of long standing, they frequently offer a good deal of resistance to the knife, perhaps even emitting a sort of grating noise. On being laid open, they are found to be rough and irregularly sacculated, strong bands being sometimes stretched across their interior, which divide the tube into small cells, occupied by coagulated blood, phlebolites, or fibrinous concretions, in a state of organization. In the advanced stages of the disease many of the valves are broken down, if not completely destroyed, while in recent cases they are simply thickened, indurated, displaced, or ruptured. These changes, which are generally most conspicuous in the internal saphenous vein and its branches, are obviously brought about by chronic inflammation, or by repeated attacks of the acute form of that disease, and often lead to great and irreparable mischief. Occasionally, the affected vessels are converted into dense, rigid, and impervious cords, altogether disqualified for the discharge of their functions. In confirmed cases of varix of the lower extremity, the superficial, intermuscular, and deep-seated veins most commonly suffer together. Very frequently, indeed, the disease begins in the latter vessels, and gradually, through the intermuscular branches, extends to the former.

The state of the vessels here described is well depicted in fig. 363, taken from a patient of mine, a stout, robust, laboring man, upwards of fifty years of age. The enlargement, which was much greater than any of the kind I had ever seen, was principally situated on the inner surface of the limb, and was associated with similar disease of the veins of the scrotum, penis, and abdomen.

The disease may be caused in various ways. In the inferior extremities of pregnant females, it is generally induced by the pressure of the distended uterus, creating a mechanical impediment to the return of the blood in the iliac veins, and, indirectly, in the saphenous. Wearing tight garters, drawers, or stockings, may also occasion the disease, and a similar effect is brought about by the habitual maintenance of the erect posture. Hence the disease is very common in persons who are compelled to stand much. Varix of the hemorrhoidal veins generally depends upon habitual distension of the rectum and frequent straining in defecation. The causes of varicocele are still imperfectly understood, although there is reason to believe that the disease is most commonly developed under the influence of onanism, and other mechanical obstruction tending to weaken the spermatic veins.
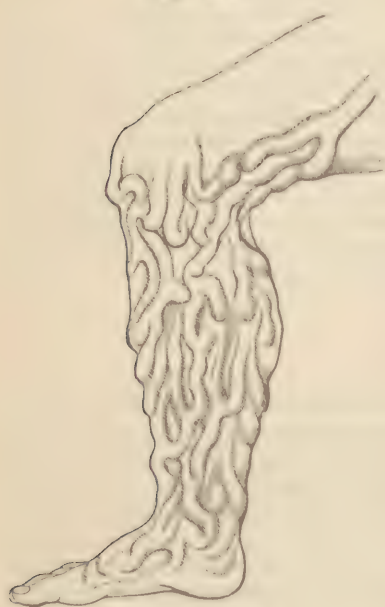
Fig. 363.

Varix of the Leg.

A natural predisposition to varicose enlargement occasionally exists in certain individuals; the veins seem to be unusually large and feeble, and become tortuous and dilated under the most trifling obstacles to the onward movement of their contents. When this is the case, the disease often occurs simultaneously in different parts of the body, superficial as well as deep.

The effects of varicose veins vary according to the situation of the malady. In the legs, the pressure of the enlarged and distended vessels is always productive of a good deal of pain, of a pricking or stinging nature, of tumefaction of the skin and connective tissue, and of more or less tenderness along the track of the affected veins. In the more aggravated cases, ulceration of the integument is apt to take place, commencing usually at one particular spot on the inner surface of the limb, and gradually progressing until a large sore is established, called, from this circumstance, the varicose ulcer, which always heals with difficulty, and which occasionally extends into the enlarged veins, causing copious, if not fatal, hemorrhage. In the spermatic veins, the disease may give rise to atrophy of the testicle, and to distressing neuralgic pains; while in the hemorrhoidal it leads to the formation of piles, and other disagreeable effects.

Although the development of varix is generally slow, cases occasionally occur in which the reverse is the case. During the latter months of utero-gestation, the veins of the feet, legs, and thighs often attain an enormous bulk in a few weeks, and I have seen repeated instances of a similar kind in the spermatic and hemorrhoidal veins. In the inferior extremity, the disease, after having gone on for some time, often remains stationary for an indefinite period, neither perceptibly advancing nor receding. In some instances it undergoes a sort of spontaneous cure, inflammation being set up in the affected veins, followed by the formation of fibrinous concretions, by which their caliber is ultimately rendered so completely impervious as to compel the blood to seek other channels. Instead of this favorable result, the inflammation occasionally leads to erysipelas, abscess, pyemia, and even death. Varicocele never proves fatal, nor does varix of the hemorrhoidal veins, although both are, at times, a source of severe suffering.

Treatment.—The treatment of varix resolves itself into palliative and radical. The former consists, as the term implies, in the removal of the exciting cause of the disease, and the adoption of such remedies as tend to relieve the part and system of suffering without positively curing the malady. In varicocele, onanism must be interdicted; in varix of the hemorrhoidal veins, straining and constipation must be counteracted; and in varicose enlargement of the veins of the lower extremity, all sources of constriction must be removed, together with whatever else may have a tendency to weaken, irritate,

and inflame the diseased structures, and thereby occasion further enlargement. Giving artificial support to the affected veins often has a good effect. Hence the use of the suspensory bag in varicocele, and of the laced-stocking in varix of the saphenous vein. In every form of the lesion, great benefit accrues from attention to the general health, and from the occasional administration of an active purgative, which, by clearing out the bowels, thus affords a freer passage to the blood in the diseased veins towards the heart. If the patient is very plethoric, blood may sometimes advantageously be abstracted. In varix of the legs commonly nothing affords more prompt and satisfactory relief than a good bleeding at the arm; and the same remedy must be called into requisition, along with astringent and anodyne lotions and perfect rest of the parts, when the veins are unusually tender and painful from accidental access of inflammation.

For the radical cure of this disease numerous operations have been devised, a few only of the more important of which need to be noticed here, as the rest have either fallen into merited neglect, or are too dangerous to justify their repetition. Besides, the claims of these different operations will more naturally come to be considered in speaking of the several varieties of varix, as varicocele and hemorrhoids. There are really only two operations which, according to my experience, should ever be practised for the permanent relief of this disease, namely, the ligature and the caustic issue; and if we apply these remedies to individual forms of the lesion, it will be found that the former is exclusively adapted to varicocele and hemorrhoids, and the latter to varix of the feet, legs, and thighs. Both procedures are extremely simple, but, although this is true, they should never be employed without a thorough preparation of the part and system; and I deem this the more necessary, because, in the great majority of cases upon which we are obliged to operate, the disease is rather an inconvenience than a serious evil, threatening loss of limb and life. I will not pretend to assert that there are no cases of varix when an operation is not absolutely necessary; to do this would be absurd; what I mean is simply that no man, however skilful or experienced, should endanger his patient's life by rushing headlong into measures which, if injudiciously used, may lead to the worst results. The preliminary treatment should be mild, but of longer duration than in ordinary diseases; the object is to remove all irritation that may exist in the affected veins, to soothe and calm them, in order that they may be the better prepared to withstand the rude assault about to be made upon them. To accomplish this object, the patient must be subjected to light diet, gentle purgation, and almost absolute rest in the recumbent or semierect posture, for at least a week. This will be the more important if he be plethoric, intemperate, or very excitable. When it is remembered how intolerant the veins are of injury and of surgical interference, such precautions cannot be considered as idle.

The operation with the ligature is either direct, as in piles, or subcutaneous, as in varicocele, and in either case it is as safe as it is effectual. The principle on which it operates is that of strangulation, by which the enlarged vessels are converted into a slough, which is subsequently detached by ulcerative action. For this purpose it is necessary to draw the cord with great firmness, so as to produce this result in the shortest possible period, as well as with the least suffering. When the ligation is direct, as in hemorrhoids, it is always necessary to encircle the base of the tumor, or to tie it as near as practicable to its point of attachment to the bowel. When the base is unusually large, it is sometimes transfixed with a needle armed with a double ligature, one of which is then drawn around each half of the morbid growth, the object being its more effectual strangulation. The subcutaneous operation is particularly applicable to varicocele, although it is sometimes also practised upon the leg and thigh in varix. It is performed by means of a stout spear-pointed needle and a strong ligature, introduced in such a manner as to avoid the spermatic cord, the instrument making only two punctures, one in front of the scrotum and the other behind, by retracing its steps after it has effected transfixion. The ends of the cord are then firmly tied in the usual manner, the pressure being increased from day to day until the ligature is completely detached, or but feebly adherent.

In operating upon the veins of the inferior extremities, my experience is that the safest plan is the establishment of a series of issues, made with the Vienna paste, the proper mode of applying which will claim special attention in the section on varix in the second volume.

The after-treatment is not to be disregarded in these operations. The great danger is a bad form of erysipelas, connected, doubtless, with phlebitis, its tendency being to diffuse itself extensively over the system, and to give rise to pyemia and typhoid symptoms. I have not myself, however, witnessed any such effects in any of my cases, and I am inclined to ascribe my good fortune more to the pains I have always taken in preparing my patients

than to any particular skill in performing the operation or in conducting the after-treat-ment. If everything goes on well, little else will be necessary than strict attention to the diet, and quietude of the part and system, with an occasional laxative ; if erysipelas super-vene, the use of opium, quinine, and iron will be indicated, along with milk punch, and the application of iodine, astringents, and emollient cataplasms.

Excellent cures of enlarged veins have been effected by injections of the solution of subsulphate of iron, consisting of one part of the officinal preparation to twenty or thirty parts of water. Used stronger than this, the remedy is liable to excite undue inflammation.

SECT. IV.—INTRODUCTION OF AIR.

A fatal, although, fortunately, not a common occurrence, incident to certain operations, is the accidental introduction of air into the veins. It is most frequent in operations about the neck, face, and axilla, and was first noticed, as a distinct event, in 1818, by Beau-chesne, in exsecting a tumor from the cervical region of a young man, in which it was necessary to disarticulate and raise the clavicle. At the moment of effecting this, the patient became faint, and, exclaiming that he was dying, expired in less than half an hour afterwards. The examination of the body revealed the existence of an aperture in the internal jugular vein, at its junction with the subclavian, through which the air, causing the fatal result, had, doubtless, entered the circulation. Shortly after this, a similar acci-dent happened to Dr. Mott and Dr. Stevens, as well as to several European surgeons, so that, in due time, the attention of the profession became fully aroused to the nature and importance of the subject.

The disastrous effects of the introduction of air into the venous circulation were known, long ago, to Wepfer, Vander-Heyden, and other physiologists ; but they were lost sight of, in great measure, until attention was recalled to the subject by the experiments of Bichat, Nysten, and Magendie, who showed that a very small quantity of this fluid, sud-denly injected into the jugular vein of dogs and other animals, was sufficient, in most cases, to cause death almost instantaneously. On the other hand, it has been found that a large quantity, as, for example, several cubic inches, will not destroy life, if it be intro-duced slowly, the air, in this case, combining with the blood in such a manner as to pre-vent it from producing any serious mechanical inconvenience. Upon dissection, air is readily discovered in the cavities of the heart, as well as in other parts of the circulatory apparatus, thus accounting satisfactorily for the fatal event.

The *symptoms* which characterize the entrance of air into the venous system are essen-tially those of cerebral apoplexy. The patient is generally seized, suddenly and unex-pectedly, in the midst of the operation, with a sense of faintness, or a horrible feeling of terror, oppression, and exhaustion, inducing him to believe, and, perhaps, to exclaim, that he is dying. The countenance, in a moment, assumes a dark, livid hue, the body is agi-tated with convulsive movements, the breathing is slow, difficult, and stertorous, the muscles are completely relaxed, the pulse is feeble and almost imperceptible, the pupils are dilated, and the individual is wholly unconscious. In short, he dies in a state of pro-found coma, like a person in a fit of apoplexy. On applying the ear to the cardiac region, the action of the heart is found to be excessively oppressed, the organ struggling power-fully to overcome the mechanical obstruction caused by the admixture of the gaseous and sanguineous fluids, which, swept slowly and heavily along over the fleshy and tendinous columns, occasions a loud, churning noise, synchronous with the contraction of the left ventricle, and at the same time a peculiar thrill, or vibratory sensation, perceptible by the hand as it rests upon the chest.

Such are the effects usually observed when air has been introduced suddenly, even in small quantity, into the venous circulation ; and there is a strong probability that they will steadily increase in severity until they prove fatal, despite the most judicious and energetic measures that may be employed to counteract them. The period at which death occurs varies from a few minutes to several hours ; occasionally life is destroyed almost with the rapidity of lightning, and in most cases in from twenty to forty-five or fifty minutes. The fatal event, if not instantaneous, is always preceded by a rapid reduction of the temperature, and by a diffusion of the lividity over the whole body, the surface being of a leaden hue, as in death from asphyxia. Cases have been noticed in which, after the symptoms had continued for some time in a very bad form, the purplish appearance of the cheeks was suddenly replaced by a reddish tinge, affording evidence, although gen-erally of a deceptive character, of speedy reanimation and ultimate recovery.

The immediate cause of death, in this accident, has been variously explained ; indeed,

it is remarkable what little coincidence of opinion there is upon the subject among writers. From the fact that air has occasionally been found in the right cavities of the heart, after surgical operations in man, and in animals after experiments, it has been assumed that it was the inability of this organ to contract upon its contents, and thus send a sufficient quantity of blood to the lungs and brain for the due performance of their functions. Others have maintained that the primary trouble is in the pulmonary tissues. Thus, Mr. Erichsen supposes that it depends upon the manner in which the air and blood are beaten up together in the right cavities of the heart into a spumous fluid, which is unable to pass through the lungs, thus depriving the brain and spinal cord of their due supply of blood, and inducing fatal syncope, usually attended with convulsions. In opposition to this view, it may be stated that, if air be injected in considerable quantity into the carotid artery of an animal, all the phenomena of apoplexy, such as stertorous breathing, loss of sensibility, and spasmodic rigidity of the muscles, will instantly be produced, and soon occasion death from obstruction of the cerebral circulation. Whatever of truth these different explanations may embody, it is evident that the secondary effect of the presence of the gaseous fluid, that which really causes the fatal termination, is the want of a sufficient quantity of oxygenated blood in the great tripod of life, the heart, lungs, and brain.

If the patient survive, the transition to health is seldom instantaneous; on the contrary, several hours generally elapse before he recovers his consciousness and strength. In a case mentioned by Dr. Warren, the man, after having lain in a state of insensibility for two hours and a half, awoke as if from a profound sleep, still breathing, however, apoplectically. The night was passed without any accident, and on the following morning he was as well as usual, except that he had a headache, and some soreness in the chest. Sometimes the patient recovers from the immediate consequences of the accident, but dies afterwards from pneumonia, produced, probably, by the irritating effects which the fluid exerts upon the pulmonary capillaries, and through them upon the air-vesicles. Such an occurrence, however, is uncommon.

The local phenomena accompanying the introduction of air into the veins are of great interest, particularly in their diagnostic relations. In general, there is some noise, or sound, so loud and distinct as to be plainly perceived by the operator and his assistants, and which, occurring in combination with the sudden distress of the patient, is of the utmost value as a means of discrimination. In some cases, the sound is of a hissing nature, like that arising from air rushing into a narrow and exhausted receiver; in some, it is bubbling, clucking, or lapping; in some, gurgling, sucking, or licking. The immediate causes of these variations are, the size, shape, and situation of the opening in the injured vein, the quantity of blood in the wound, and the volume of the vessel and the relation which it bears to the surrounding parts. Whatever may be the nature of the sound, or the degree of its intensity, it cannot, when once heard, be forgotten, and is always clearly characteristic of the accident. In addition to this phenomenon, there is occasionally, but by no means constantly, an appearance of bubbles of air about the wound in the vein, especially if it be somewhat deep-seated.

The veins through which air is usually spontaneously admitted in surgical operations are those about the neck, particularly the external and internal jugular and their immediate branches. It may also enter by the veins of the face, the axilla, and the chest. Thus, in one of Dr. Mott's cases, it passed in through the facial vein during the extirpation of an enlarged parotid gland. Dr. Warren met with an instance in which it was introduced by the subscapular vein; Clemot saw it enter by the veins of the chest; and Delpech had a case in which it gained admission by the axillary vein. In operations on the trachea, and in the removal of tumors from the anterior part of the neck, the veins lying in this region might easily be wounded so as to let in air.

A case in which the introduction of a seton in the forepart of the neck was followed by the entrance of air into the veins has been recorded by Dr. Willis, of England. The patient, who had labored under chronic laryngitis, died in seven hours after the operation. The large cervical vessels were found, on the dissection, to be uninjured, but the right auricle and pulmonary artery were distended with frothy blood, and the lungs were emphysematous.

The reason why the veins in the localities here enumerated alone are subject to this accident is that they are under the influence of a suction action during inspiration, owing to a tendency to the formation of a vacuum within the chest during the expansion of the lungs. This action is naturally limited to the veins at the root of the neck, and it is here, therefore, that air is most liable to be introduced spontaneously; it may, however, as has already been stated, pass in through the veins of the face, axilla, and thorax, but in order

to do this it is necessary that these vessels should be in the condition of rigid tubes, or in a state of canalization; for if they are merely collapsed, flattened conduits, it is evident that the air will not be able to enter them, however freely they may be punctured. There are various circumstances which may induce this accidental canalization of a vein, of which the principal are the adhesion of its walls to the parts through which it passes, and the manner in which it is held during the operation, rendering it open-mouthed and gaping when divided. Sometimes the introduction takes place in a perfectly healthy vessel at a considerable distance from the root of the neck, in consequence of the tension into which it is thrown by the position of the head and arms, as happened in one of Warren's cases, where the air was admitted by the subscapular vein. The probability of this occurrence is much increased when operations are performed upon the neck, face, and axilla, for the removal of large tumors, especially such as are of a glandular nature, including veins of considerable size. In injury of the jugular veins the accident will be most likely to happen if the wound is made just above the clavicle, where the suction action is naturally strongest. Air thrown into the veins in remote parts of the body will destroy life as promptly and effectually as when it enters in the localities above alluded to, and the only reason why the accident so seldom occurs in them is that the vessels are not under the immediate influence of the respiratory organs, as they are about the neck and chest. Legallois witnessed three cases of instant death in female animals from the introduction of air into the inferior vena cava and heart by the uterine veins, and the same occurrence has been met with in the human subject.

Treatment.—The treatment of this accident is preventive and curative. For the former, different plans have been suggested, most of which may occasionally be adopted with advantage. In the first place, the operator should remember where, and under what circumstances, such an occurrence is most likely to happen; for, being thus put upon his guard, he will be more cautious in the movements of his knife, and thereby, in all probability, altogether avoid the much dreaded mischief. Secondly, when he is about to begin his incisions, an intelligent assistant should compress at the root of the neck any veins that may be within reach, and, consequently, in danger of being injured in the early stage of the procedure. As a preliminary step in operations in this region I occasionally pass a pin underneath the jugular vein, and twist the thread around it, as in the common harelip suture. In conducting the deep dissection, he should make careful use of the handle of the scalpel, as well as of his fingers, to detach the morbid structures, or to separate the sound, as the case may be, and if it be found that any veins are included within them, so as to require to be severed, they should at once be secured with the ligature at the cardiac side of the tumor. Sometimes a temporary ligature may be proper, to be removed, or tied, after the completion of the operation, according to the exigencies of the case. It has been recommended that, when we are compelled to divide any of the vessels about the neck, the patient should be desired previously to make a full inspiration; such a procedure, however, would hardly be safe unless the vessel should become instantly collapsed, and remain so afterwards. Thirdly, in operating in the different regions under consideration, care must be taken to avoid those positions of the head and arm which are calculated to produce tension and canalization of the veins. Fourthly, it having been found that the entrance of air into the veins can be prevented in the inferior animals by compressing the chest and abdomen, Mr. Erichsen strongly insists upon the propriety of swathing the body as tightly as the comfort of the patient will admit, with the view of compelling respiration solely by the diaphragm. Such a plan I should think of questionable utility, especially if the patient requires the use of an anæsthetic during the operation. Lastly, should the accident happen, notwithstanding every possible precaution, as indicated by the occurrence of the peculiar hissing, clucking, lapping, or gurgling noise, previously mentioned, or by the appearance of bubbles about the wound in the vein, compression must instantly be applied, and all further proceeding suspended until the trouble is effectually remedied.

To recover a patient from the effects of this accident, various methods of treatment have been proposed, some of which are, to say the least, anything but philosophical. Thus the idea of sucking out the air from the injured vein, a plan proposed by a French surgeon, by the introduction of a suitable instrument, such as a silver canula or catheter, amounts to little less than positive absurdity; for, independently of the difficulty and tediousness of such an operation, it would be far more likely to be followed by an additional entrance of air than the abstraction of that which has already been admitted. But, even granting, for the sake of argument, that a tube could readily be passed into the vein without the risk of letting in more air, it would not be practicable to remove the fluid from the lungs, which it must necessarily reach within a few seconds after the occurrence

of the accident. Once admitted, no skill can dislodge it, either by this or any other means. When the patient is plethoric, and has lost but little blood during the operation, it has been recommended to open the temporal artery, on the ground that it might have the effect of removing cerebral and pulmonary congestion, and thus favoring the restoration of the circulation. The utter futility of such a procedure must be apparent, when it is recollected that this congestion depends, not solely upon an imperfectly aërated blood, but also upon the presence of a spumous fluid, which the capillaries are incapable of propelling onward. The same remarks are applicable to the section of the right jugular vein, which, it has been alleged, might prove beneficial by unloading the corresponding cavities of the heart.

The fact is, all that can be done, in any case of this kind, is to make an effort to support the system. With this view, the treatment should be conducted very much upon the same principles as in syncope from the loss of blood, or in asphyxia from drowning. The patient is laid at once recumbent, with the head and shoulders even lower than the rest of the body, and, if the circulation is still going on, firm pressure is immediately applied to the axillary and femoral arteries, or the limbs are enveloped in elastic bandages, for the purpose of allowing as free an access of blood to the heart and brain as possible. Sinapisms of the most powerful kind are applied to the extremities, the spine, and the precordial region, or, what is far better, the body and extremities are thoroughly and persistently flagellated with the end of a fringed towel wet with hot water. As soon as reaction has been established, the body is wrapped up in warm blankets, at the same time that cold air is freely admitted to the nose and mouth. Brandy and ammonia are freely given, if the patient can swallow ; otherwise these fluids must be promptly injected into the rectum. Finally, as a dernier resort, artificial respiration should be established, by means of a tube introduced through the glottis, or through an opening in the larynx, and steadily and faithfully maintained until some time after all signs of breathing and circulation have disappeared.

CHAPTER VII.

AFFECTIONS OF THE CAPILLARIES.

THE capillaries are liable to enlargement, consisting of a species of hypertrophy of their tunics, with more or less dilatation of their caliber. The disease may be limited to the arterial capillaries, or to the venous capillaries, or it may involve both classes of vessels, constituting thus a kind of compound affection. However this may be, the consequence of the enlargement is the formation of a distinct tumor, which may eventually acquire a large bulk, and seriously compromise the safety of the patient, especially when it is of an arterial character. The disease is generally, if not invariably, congenital, and it is, therefore, not uncommon to find that it has made considerable progress before birth. It is to this group of lesions that the term nævus is usually applied. Vulgarly they are known as mother's marks, or blood marks. The term nævoid, or nævous-like, is also frequently employed.

SECT. I.—ARTERIAL TUMORS.

The only arterial tumor, properly so called, that can be recognized, in a practical sense, is that which was originally so ably and graphically described by John Bell, of Edinburgh, under the name of aneurism by anastomosis. His account of the disease is by far the most clear and elaborate that has yet appeared, and it is remarkable that hardly anything of importance has been added to it by subsequent observers, either as it respects its anatomy, etiology, or mode of treatment. The only error which the Scotch surgeon committed was the assertion that the lesion was peculiar to adults, and that it was a perfect aneurism.

The most common sites of the arterial tumor are the scalp, lip, nose, orbit, eyelid, cheek, and chin ; it may, however, occur in any part of the body, and I have repeatedly met with it upon the shoulder, trunk, fingers, and foot. Some years ago, I removed a considerable tumor of this kind from the big toe of a young man of twenty-two. I have also seen examples of the disease in the vulva of young girls. The texture in which it is usually situated is the connective, especially the subcutaneous and submucous ; I do not recollect ever to have seen it anywhere else, although its occasional occurrence has been

noticed in the liver, spleen, and kidney. In the bones of the skull it occupies the diploë.

The tumor is essentially composed of a network of arteries and capillaries, closely connected together by fibrous tissue, as exhibited in fig. 364. It is, in fact, originally nothing but a species of hypertrophy of the capillary vessels, commencing in a little speck, perhaps, not larger than the head of a pin, and going on gradually enlarging until, at length, it acquires an enormous volume. The arteries, which are free from the earthy and fatty degeneration, have a singularly convoluted arrangement, and, in cases of long standing, or of extraordinary bulk, some of them are often as large as a small goosequill; their walls are disproportionately thin and diaphanous, and from being pressed out laterally into short, blind pouches, it is very common for them to have a sacculated appearance. This increase in the caliber of the arteries is not limited to the tumor, but always extends some distance beyond its proper boundaries, as can readily be ascertained by a careful examination with the finger; in fact, it is sometimes easily detected with the naked eye. The general disposition of the veins is similar to that of the arteries; they are, however, usually less capacious, relatively considered, and hence the blood returns with less facility than in parts naturally constituted.
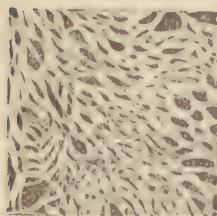
Fig. 364.

Anastomotic Aneurism.

The tissue by which the vessels are connected together is, in the first instance, nothing but ordinary connective substance, naturally existing in the part where the tumor is developed; it is perfectly soft, spongy, and extensible. In time, however, it necessarily undergoes important changes, brought about by the pressure exerted upon it by the impetuosity of the inflowing blood, and by its temporary sojourn in the midst of the morbid mass. Hence it is that, while in some situations it exists most sparingly, so much so, indeed, as to be hardly demonstrable, in others it is preternaturally abundant, and truly fibrous.

Such are the grosser elements of this form of tumor. Examined more minutely, it is found to consist of a kind of areolar structure, the cells of which, varying in size from that of the smallest pin's head to that of a pea, freely communicate with each other, not unlike those of a sponge, by means of lateral pores. These cells, which exhibit every diversity of shape, are formed apparently by the ampullar expansions of the coats of the arteries, and bear, in their general character, a considerable resemblance to those of the erectile organs, as the penis and clitoris. In old tumors of this description, some of the sacs occasionally become closed, thus assuming, as it were, an independent existence. The cause of this occurrence is probably inflammation, leading either to direct adhesion of the contiguous surfaces of the arteries, or to the formation of coagula. The contents of these cysts are either sero-sanguinolent or sanguineous. In the latter case they are generally solid.

Finally, the arterial tumor has no distinct, separate envelop; the only covering which it has is derived from the superincumbent structure, as the skin or mucous membrane, which, in time, becomes atrophied by the incessant beating of the blood beneath, and ultimately gives way by ulcerative action. In general, the surface of the tumor is of a reddish scarlet hue, with here and there a purple spot, and so transparent as to allow many of the enlarged vessels to be seen through it. Occasionally a few granules of adipose matter overlie the tumor, or are dispersed through its substance.

It will thus be perceived that this tumor is in reality not a true aneurism, preceded and accompanied by the fibrous, earthy, or atheromatous degeneration, but simply an abnormal dilatation of the capillary arteries, involving, in time, the larger arteries in their immediate vicinity, and attended by a corresponding but less developed state of the capillary and adjacent veins. It consists, in fact, clearly and distinctly, in a hypertrophied condition of these vessels; or, in other words, as was previously remarked, in a gradual evolution and growth of arteries and veins from tubules that are imperceptible by the naked eye to vessels of extraordinary size. There is no addition of new vessels, at least not originally, but the whole tumor is formed out of those which naturally exist in the part, enlarged in every direction, in length as well as in diameter, under the pressure of the steadily increasing afflux of blood. The coats of the vessel are not, it is true, as thick and firm as those of the arteries and veins, properly so called, usually are, but the aggregate capacity is so much greater than what the part naturally possesses that it must be regarded as essentially a product of supernutrition.

The origin of the arterial tumor is often ascribed to the effects of external violence, as a blow or fall, and that it may occasionally be so excited is highly probable; in general, however, it arises without any assignable cause, as a nævus, or mother's mark. Indeed,

I am inclined to think that the affection is nearly always congenital, even in those cases in which it is said to have arisen in the adult. This may be accounted for on the assumption that the nævus was originally so exceedingly minute as to have entirely escaped attention, until it began to assume an active character. However this may be, the starting-point of the disease is usually a little reddish speck, not larger than the head of a small pin, perfectly free from pain, and seated just beneath the skin, or partly in the skin and partly in the subcutaneous connective tissue. Its growth is generally very gradual, so that a number of months, and perhaps even several years, may elapse before it attains the volume of a pigeon's egg. Occasionally, however, it increases with great rapidity, and soon acquires a frightful bulk, as in a case under my care, not long ago, in a female child, thirteen months old. At birth a reddish spot, as large as a dime, was observed at the centre of the left cheek. At the end of five weeks it had nearly doubled its dimensions. A charlatan now applied some caustic substance, eventuating in a large slough. The sore, which was the seat of occasional hemorrhage, healed in a little more than two months, leaving an unseemly scar upwards of two inches in diameter, with red, spongy edges. A year after the use of the escharotic, when I first saw the child, the tumor was of immense volume, horribly disfiguring the features, and occupying the whole of the left side of the face, extending forwards to the nose and mouth, upwards to the eyelid and temple, backwards behind the ear, and downwards into the neck, its antero-posterior diameter being eight inches and a half, and the vertical six. The tumor, of a bluish color, and of a soft, spongy consistence, sensibly increased whenever the child cried, laughed, sneezed, or coughed. At its lower and back part it had a peculiar aneurismal thrill and bruit, synchronous with the action of the heart. During the last few months the inside of the cheek had become much enlarged, and now presented a knotty feel and a bluish appearance. The upper jaw, along its alveolar process, was of unusual size, evidently from the same cause, and was beginning to encroach seriously upon the mouth. The swelling was free from pain, and there was no disorder of the health.

In general, however, the tumor proceeds more slowly, and we not unfrequently meet with cases in which, after having made some progress, it remains for a while stationary. When it begins as a nævus, or mother's mark, it is not unusual for it to continue as a little reddish spot for several years, when, its activity being aroused, how or why we know not, it grows with unwonted vigor, and soon attains a large bulk. The tumor has generally an irregular outline, and rarely projects more than a third or half an inch beyond the level of the surrounding parts. It is soft and compressible, the finger sinking into it as it would into a wet sponge, but the moment the pressure is removed it regains its former volume, the blood rushing into it with a peculiar whizzing or blowing noise. Its color varies in different cases; when it occurs in the skin, or skin and connective tissue, it is generally of a reddish hue, inclined to scarlet, especially in its earlier stages; but in all cases, and especially when it lies beneath the mucous membrane, it is more commonly of a bluish or purplish color. It beats and throbs synchronously with the contraction of the left ventricle of the heart, and imparts a peculiar aneurismal thrill to the finger. Its movements are often perceptible at a considerable distance, and are always sensibly augmented under the influence of mental emotion. When of considerable volume, the tumor may produce severe pain and other inconvenience by its pressure, but, as a rule, there is little local suffering or constitutional disorder.

Such a tumor sometimes ulcerates and sloughs, causing more or less hemorrhage, and ultimately, perhaps, death, as in the case of one of my patients, a female child, ten months old, who had a large congenital arterial nævus upon the right shoulder and arm, of a dark purple color, and of a soft spongy consistence, throbbing and beating violently. Although the general health was good, ulcers, after some time, began to form on different parts of the tumor, which now became very painful and inflamed, and, in a few weeks, gangrenous. The hemorrhage which succeeds the ulceration in this affection, profuse as it sometimes is, seldom proves fatal; for, after it has continued for a while, the blood coagulates upon the eroded surface, and thus prevents further effusion. In the female, the hemorrhage is occasionally vicarious of the menstrual flux; the tumor becomes full and tense at the return of each period, and, giving way at the top, allows the blood to drain off, without serious injury to the parts or system. It has been asserted that such a growth may degenerate, changing its primitive character, and assuming one of a worse kind, as the sarcomatous. Without altogether denying the possibility of such an occurrence, I have never seen anything to justify the conclusion.

Treatment.—The treatment of this form of tumor may be conducted by excision, escharotics, strangulation, starvation, injections, and, lastly, by amputation, as when the disease occupies one of the extremities. Besides these methods, there are several others

of a more doubtful and less trustworthy character, which will be briefly noticed in their proper place.

α. *Excision* is chiefly adapted to small arterial tumors, before they have acquired much functional activity, or given rise to any enlargement of the neighboring arteries. The operation is then perfectly safe, easy of execution, and likely to be entirely successful. But if the case be neglected until the morbid growth has attained a large bulk, beating and throbbing violently at every pulsation of the heart, as if it were ready to burst, the attempt, besides proving one of immense difficulty, may be attended with so copious a hemorrhage as to cause speedy exhaustion ; we have then a formidable enemy to deal with, and we may consider ourselves fortunate if the patient do not perish from the loss of blood, gushing forth, as it will, in torrents, at every stroke of the knife. In such a case the prudent surgeon weighs well, before he begins his perilous operation, the chances of success ; he measures every inch of ground, and equips himself thoroughly, at every point, for the trials and perplexities of his portentous undertaking.

When excision is determined upon, the rule of practice is, as John Bell long ago so correctly observed, not to cut into the tumor, but around it, and yet not so widely around it as to include an unnecessary quantity of sound tissue. The operation is performed rapidly, the finger of a good assistant quickly following the knife in order to compress any important artery that may be divided, until the whole mass is completely extirpated; and it will be wise, if practicable, always to arrest the circulation in the main artery leading to the tumor before we begin the incisions. Removal being thus effected, the ligature may often be entirely dispensed with, all bleeding ceasing the moment the operation is over ; or as soon as the edges of the wound are thoroughly approximated by the twisted suture, a mode of dressing peculiarly adapted to this form of disease, on account of the hemostatic influence exerted by its compression.

Fig. 365.
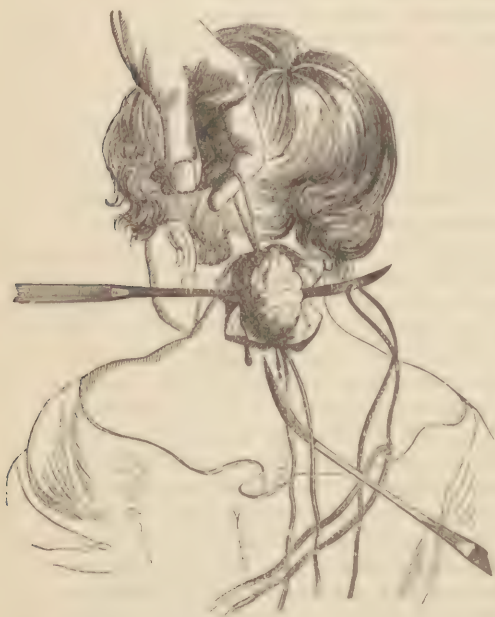
Erectile Tumor. The Integument, uninvolved, has been reflected by Flaps : Transfixion is being completed, previous to Deligation. The larger Ligature, in the act of being pulled through. It fills the aperture of puncture, preventing Bleeding ; and, besides, bears a stronger strain on tying.

The cutaneous method of removing næevoid and other vascular tumors, suggested by Mr. T. P. Teale, of Leeds, has been successfully practised in a number of instances. It consists in dissecting off the skin, as a preliminary step, and then replacing it, experience having proved that, when the case is thus managed, the enlarged vessels gradually shrink, and eventually all trace of disease disappears.

β. Small arterial tumors may often be readily destroyed by *escharotics*, of which the Vienna paste, used as in making an ordinary issue, is preferable to any other. The paste is retained for fifteen minutes, being spread out sufficiently to cover the whole of the affected surface ; the application is followed up by an emollient poultice, and when the slough is detached the sore is treated upon general principles. When the tumor is very large, and so situated as not to involve any important structures, interference with which might prove prejudicial, it may be attacked, either simultaneously or successively, at several points of its extent, for the purpose of converting the whole mass into an eschar. For obvious reasons the caustic should not be used upon those parts of the body which are habitually exposed, as the face and neck.

γ. *Strangulation* may be effected by transfixing the base of the tumor with one or more pins, and then drawing a ligature firmly around them, so as to cut off at once, and effectually, its sanguineous supply. Or, instead of this, a stout, double thread may be conveyed beneath and around it by means of a spear-pointed needle, provided with an eye, one cord being tied upon one side of the swelling, and the other upon the opposite side. If the

integument be sound, the ligation is preceded by its careful division and reflection, as in fig. 365, in order that, when the morbid growth has been removed, it may be replaced, and thus serve to protect the parts from an unseemly cicatrice.

When the tumor is so flat and elongated as not to admit of inclusion by the quadruple ligature, recourse may be had to the ingenious expedient of Erichsen, which combines the great advantage of thorough strangulation with a small ultimate cicatrice, it being unnecessary to embrace an undue quantity of integument for the eradication of the disease. The operation is performed in the following manner. "A long triangular needle is threaded on the middle of a whip-cord, about three yards in length; one-half of this is stained black with ink, the other half is left uncolored. The needle is inserted through a fold of the sound skin, about a quarter of an inch from one end of the tumor, and transversely to the axis of the same. It is then carried through, until a double tail, at least six inches in length, is left hanging from the point at which it entered; it is next carried across the base of the tumor, entering and passing out beyond its lateral limits, so as to leave, as shown in fig. 366, a series of double loops about nine inches in length on each side. Every one of these loops should be made about three-quarters of an inch apart, including that space of the tumor, and the last loop should be brought out through a fold of healthy integument beyond the tumor. In this way we have a series of double loops, one white, and the other black, on each side, as in fig. 367. All the white loops should now be cut on one side, and the black loops on the other, leaving hanging ends of thread of corresponding colors."
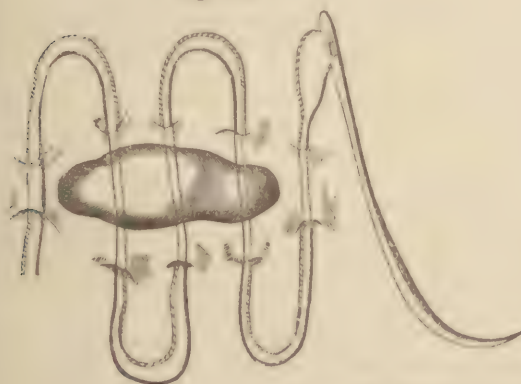
Fig. 366.   Fig. 367.

Erichsen's Mode of Ligating Vascular Tumors.

"The tumor may now be strangulated by drawing down and knotting firmly each pair of white threads on one side, and each pair of black ones on the other. In this way the tumor is divided into segments, each of which is strangulated by a noose and a knot: by black nooses and white knots on one side, by white nooses and black knots on the other, as in fig. 367."

δ. *Starvation* may be attempted in one of two ways; either by tying the arteries which immediately feed the tumor, or else by occluding the main vessels which lead to the parts where the tumor is located. Of these two methods, preference should always, if possible, be given to the former, on account of its having a more direct and controlling influence upon the arrest of the morbid growth; when the swelling is very large, the two plans may sometimes be advantageously combined. Ligation of the arteries in the immediate vicinity of the tumor should be performed at several points at once, otherwise but little impression will be likely to follow; and care is taken, in performing the operation, not to interfere with the proper substance of the tumor, lest embarrassing hemorrhage ensue.

Deligation of the main artery leading to the parts upon which the morbid growth is situated has hitherto been practised chiefly upon the common carotid, in aneurism by anastomosis of the orbit, face, and scalp. The success has been variable, but, in the main, not very flattering, and yet I conceive that the procedure may be very proper when no other treatment is available. The misfortune, perhaps, is, that it is always employed as a dernier resort, and it is, therefore, not surprising that it should have so often failed. Dr. Mott, in one instance, tied the common carotid artery on account of a large arterial tumor, involving both orbits, the nose, and part of the forehead, in a child only three months old; the mass gradually diminished in size, and became so much consolidated as

to lead to the belief that it might afterwards be extirpated, if such a measure should be deemed expedient. The final result of the case has not been reported. In 1828, I assisted Dr. George McClellan in ligating the right common carotid for the cure of an aneurism of the corresponding side of the face and orbit, in a child five months old. The operation seemed to arrest the growth of the tumor for a fortnight, but at the end of that time its activity was again aroused, and it went on progressively increasing until it caused death by hemorrhage and constitutional irritation. Dr. Mussey, Dr. J. Mason Warren, and others, both of this country and of Europe, have tied both carotids for the cure of this disease. The first of these surgeons applied the second ligature, after an interval of twelve days, without the occurrence of any untoward symptoms. In the case of Dr. Warren, a little upwards of a month elapsed between the first and second operations; no unpleasant effects supervened, and the patient, a man aged twenty-three years, made a rapid recovery, although the arterial tumor was of enormous size, involving the mouth, face, and neck. Professor Kuhl, of Leipsic, tied the left carotid in a man of fifty-three, and, in seventy-two days afterwards, the right carotid, on account of an extensive arterial disease of the scalp. The patient recovered, but not without considerable cerebral disturbance and repeated hemorrhages from the tumor. Of 13 cases of consecutive ligation of both carotids, 2 died. Of these Ullman, Velpeau, Buck, and Foote, performed the operation on account of anastomotic aneurism of the orbit; while it was resorted to for similar disease of the scalp or face in one case by Dupuytren and Robert, by Mussey, in two instances, and in one each, respectively, by Pirogoff, Reynolds and Van Buren, Warren, Robert, Buenger, and Kuhl. In tying two such large arteries for the cure of this affection, it is important to allow a sufficient period to intervene between the two operations for the dilatation of the collateral vessels which supply the brain, so as to enable this organ to obtain the requisite supply of blood for the proper execution of its functions. Several cases, it is true, have been published, in which the ligation was performed after a very brief interval, without any serious detriment to the cerebral circulation, but this fact does not invalidate the necessity of this precaution in the class of maladies in question.

Dr. Wyeth has adduced some valuable statistics upon this subject. Of 71 cases in which the ligature was applied to the common carotid artery, 20 were cured, 20 died, 9 were improved, 16 were unsuccessful, and in 6 the result was not given. In all of these cases the operation was performed for vascular growths not implicating the orbit. Of 52 cases in which the artery was ligated for pulsating tumors of the orbit, 28 were cured, 6 died, 5 were improved, 6 were failures, and in 7 the result was not known.

ε. Of the various *injections* that have been used for the relief of this tumor, the principal are nitric acid, creasote, iodine, and perchloride of iron, introduced in small quantity, either pure or diluted, with a delicate syringe, similar to that spoken of under the head of aneurism. These fluids are all more or less irritating, while several of them are capable of exciting high inflammation; hence it is hardly necessary to add that they should be employed with the greatest possible care and gentleness. At least one case is upon record, where a drop of nitric acid, thrown into a small arterial growth of a child, caused death by convulsions. In a case under the care of the younger Teale, of Leeds, instant death followed the injection of the perchloride of iron.

The most unobjectionable injection, for the cure of this disease, is a strong solution of subsulphate of iron, a few drops of which may be deposited in different parts of the tumor, by means of a delicate syringe, the nozzle of which, introduced subcutaneously, is moved about in such a manner as to break up the coats of some of the capillary vessels. Coagulation occurs almost instantaneously, and in the course of five or ten days the whole growth drops off in the form of a slough, leaving a sore which gradually heals by granulation. By means of this salt any case of arterial or venous tumor, unless very bulky, may generally be promptly and effectually cured.

ζ. Finally, among the subordinate and less certain remedies may be mentioned the use of heated needles, vaccination, compression, the use of collodion, and the seton.

The introduction of *heated needles* into the midst of the morbid growth was strongly recommended, many years ago, by several surgeons, who followed up the suggestion by the publication of a number of cases illustrative of its efficacy. On the strength of these reports, I was induced to make trial of the remedy in a number of instances which fell into my hands shortly afterwards, but such was my disappointment that I soon abandoned it altogether as worthless.

A few cases of cure of the arterial tumor by *vaccination* have been reported, the patients having been persons whose systems had not been previously protected by this

operation. In order to prove successful, it is necessary that the virus should be inserted at different points of the affected surface, so that the resulting inflammation may be felt by the whole growth. The operation is sometimes followed by violent inflammation and high constitutional disturbance, threatening convulsions, and other serious accidents.

Compression is sometimes employed, generally by means of the pad of a truss, or of a piece of ivory, coin, or sheet lead, confined by adhesive strips, a compress, and a roller. To prove efficient, it must be made in a steady, uniform manner, the cases to which it is chiefly adapted being those in which the tumor is diminutive, and situated upon a hard, bony surface. The procedure is exceedingly unsatisfactory.

The *seton* is, perhaps, on the whole, more reliable than any other of these subordinate remedies; introduced underneath the tumor, and left there until suppuration is fully established. If the growth is small, a single thread may suffice, otherwise three or four may be necessary, or, perhaps, even a larger number. A small needle, inserted into a handle, is used, the cord being dragged through so as to fill the puncture made by the instrument, thereby preventing hemorrhage. I have treated three cases of small arterial tumors on the scalp successfully by this method.

The steady, persistent application of *collodion* has occasionally been successfully employed in arresting the growth of such a tumor, and in finally obliterating it. The treatment, which, however, is always tedious, and seldom reliable, is adapted only to the more simple forms of the disease, and to be at all effective the tumor must be situated upon a firm, bony base.

η. When the tumor is irremediable by the various measures now described, and is so situated as to admit of it, *amputation* may become necessary. Much as such a step is to be regretted, no one should hesitate to take it when the disease occupies a finger, hand, arm, foot, leg, or thigh.

SECT. II.—VENOUS TUMORS.

Under this head may be described a morbid growth composed chiefly of dilated and varicose veins, held together by connective tissue; situated, for the most part, upon the scalp, cheek, lip, and chin, but also liable to occur in other regions, as the trunk and extremities. The submucous connective substance of the mouth, tongue, and vulva may, likewise, be mentioned as occasional seats of the disease, and there is one form of hemorrhoidal tumor which evidently closely assimilates itself to it in structure. Varying in size and prominence, it may, originally, not be larger than a small pimple, which, gradually spreading in different directions, may ultimately acquire an extraordinary bulk, forming a considerable projection, and occupying a diameter many inches in extent. Its color is usually purple or claret, either continuously, or intermixed with various shades of red; occasionally it is dark-mottled, especially when the enlarged veins lie nearer the surface at one point than at another, thus rendering their contents distinctly visible through the attenuated integument. In its consistence it is soft and spongy, diminishing sensibly under pressure, but speedily regaining its former bulk when the pressure is removed. It is free from pulsation, bruit, and expansion, and is comparatively little influenced by mental emotion. Sometimes the growth is tardy, at other times rapid; it is usually congenital, but may occur at any period of life; sometimes, and most generally, without any assignable cause, and at other times as a consequence of external injury. At first there is commonly no cutaneous involvement, the tumor being strictly limited to the connective tissue; by and by, however, the skin becomes uniformly attenuated, or thickened at one spot, and atrophied at another, and thoroughly incorporated with the morbid structures. As the disease advances, but generally not until the tumor has attained considerable bulk, ulceration may take place, followed by occasional hemorrhage, chiefly of a venous character, and easily checked by pressure.

The venous tumor is usually solitary; sometimes, however, it exists in considerable numbers, either in close proximity or scattered over different parts of the body. I have frequently met with them in the same person on the scalp, face, and ears. In a remarkable instance reported by Mr. Hutchinson, of London, the child had upwards of one hundred, all of them very distinct and superficial. What is vulgarly called a mother's mark, nævus or nævoid, is by far the most common form of venous tumor.

The angiomatous growth essentially consists of a network of dilated capillaries, which are, as a rule, simply an exaggeration of those which are peculiar to the part where the morbid growth is situated. They are connected together by loose connective

tissue, are more or less tortuous in their disposition, and have exceedingly thin, delicate walls, so that, when a body of this kind is excised, they immediately collapse, the structure, which previously formed a large mass, shrinking away into a little, spongy remnant. In the specimens which I have had an opportunity of examining, no abnormal vascular cells or fibrous bands were distinguishable ; and, as the operations performed for their removal were almost bloodless, it is evident that the arteries which entered into their composition must have been few in number and exceedingly small. In very old and large growths of this kind, some of the individual veins are occasionally of enormous size, as well as remarkably tortuous, and contain fibrinous and earthy concretions, lodged in separate compartments. Such occurrences are most frequent on the trunk and buttocks.

There is a form of nævoid tumor, known as *nævoid elephantiasis*, consisting of a hypertrophied condition of the skin and subcutaneous connective substance, occupied by a dense, reticulate, spongy, venous tissue of a cavernous structure, interspersed with enlarged, varicose veins, of a truly erectile character. The skin is greatly thickened, especially at certain points of the diseased surface, rugose, fissured, or tuberculated, very hard and firm, grating under the knife, studded with long, coarse hairs, and generally a few shades darker than natural. The connective tissue is much increased in quantity, of a whitish or grayish hue, and of a dense, fibrous consistence. The affection, which is either congenital or arises soon after birth, is most common in the feet and legs ; but in a number of instances I have met with it on the face, the scalp, and the trunk, more especially the side of the chest.

The venous tumor is most easily dealt with by excision, and, unless the growth is of inordinate volume, such a procedure will be almost bloodless. If any considerable artery be embraced in the general mass, it must, of course, be secured, either during the dissection, or immediately after it has been completed. The same rule of cutting around the tumor, and not into it, should be observed here as in the removal of arterial growths.

When the knife is objectionable, a venous tumor, if small, may readily be destroyed by the subcutaneous injection of a few drops of a strong solution of subsulphate of iron. The procedure, with proper care, is perfectly safe, and productive of little suffering. I have performed the operation in several cases with very gratifying results. The diseased tissues usually slough off in from five to eight days. Electrolysis is particularly applicable to such growths, which may also be readily destroyed by strangulation, either with the écraseur, the ligature alone, or the ligature and needle, in the form of the twisted suture ; if very large, however, they must not be meddled with in this way, lest violent inflammation arising, the operation may prove fatal. In nævoid elephantiasis but little is to be done beyond the steady use of the bandage and the application of dilute tincture of iodine. If the disease be seated in the lower extremity, the employment of a laced stocking will be of service in supporting the affected structures.

Venous growths, especially when they occur as nævoids, occasionally take on malignant action, after having, perhaps, been, for many years, in great degree, if not entirely, stationary. The most common changes, under such circumstances, are the epithelial and sarcomatous. An interesting example of melanotic degeneration of a congenital nævus, in a lady, forty years of age, has been reported by Dr. Stiles.

CHAPTER VIII.

DISEASES AND INJURIES OF THE BONES AND THEIR APPENDAGES.

THE bones, being organized upon the same principles as the soft structures, are liable to similar diseases, both of a benign and malignant nature. The presence of earthy matter, however, to which they are indebted for their solidity and strength, so as to render them fit organs for locomotion and protection, exerts a modifying influence upon their diseases, not only as it respects their frequency, but also their progress, the character of their products, and the mode of their termination. This influence is particularly noticeable, on the one hand, in the difficulty with which inflamed osseous tissue suppurates, and, on the other, in the facility with which it becomes softened and deprived of its vitality, even,

apparently, under very slight action. Inflamed soft texture generally suppurates with remarkable readiness, and often becomes the seat of large abscesses; in pure osteitis, on the contrary, pus is rarely seen in any form, much less in that of abscesses, such an occurrence being usually impossible, first, on account, probably, of some peculiarity in the habits of the secernent vessels, and, secondly, because of the absence of free connective substance, which, in the soft tissues, always serves as a bed for the reception and accommodation of the purulent fluid. Bones inflame with difficulty, but when the morbid process is once fairly lighted up, it is sure to produce the most serious structural disorder, often followed by the worst consequences, as softening, protracted ulceration, hypertrophy, fragility, and even necrosis. In tertiary syphilis, gout, rheumatism, and scurvy, the bones frequently suffer immensely, receiving and harboring disease with great facility. They are a common seat of various kinds of tumors, some of which, as the exostoses, are very similar to, if not identical with, their own structure, while others are essentially different in most particulars. The carcinomatous formations have not been observed primarily in the skeleton, but the frequency of sarcoma has been a subject of remark by every systematic modern writer. Tubercle, which plays so important a part in caries of the carpal and tarsal bones, in Pott's disease of the spine, and in certain affections of the larger joints of the extremities, is very common.

SECT. I.—WOUNDS AND CONTUSIONS OF THE BONES, PERIOSTEUM, AND ENDOSTEUM.

1. *Wounds of Bones.*—Wounds of bones are liable, if at all severe, to give rise to very serious consequences, both local and constitutional. In respect to their nature they admit of the same general division as wounds of the soft parts, into incised, contused, lacerated, punctured, and gunshot. In degree they may be slight or severe; and, from their situation, they must necessarily, in all cases, be more or less complicated with injuries of other structures. The articular extremities cannot suffer without more or less involvement of the corresponding joint; and in the long bones the wound often penetrates the medullary canal, thus greatly increasing the danger to limb and life.

Among the best examples of incised wounds of the bones are the injuries inflicted in surgical operations, as in cases of excision of the jaws and joints, in chopping wood, and in encounters with the sword and sabre. Wounds made with the saw, as in the amputation of a limb, are necessarily attended with a certain degree of contusion, and are on this account more liable to be followed by severe inflammation. Punctured wounds of bone are generally caused by bullets, nails, dirks, sabres, arrows, and similar weapons, and are most frequently met with in the skull, hands, and feet. Lacerated wounds are best exemplified in fractures, especially the comminuted varieties, in which the osseous tissue is not only forcibly dissevered, but torn into numerous fragments, spicules, or splinters. Penetrating wounds are those in which the lesion extends, either partially or completely, through the substance of a bone, as, for instance, in gunshot injuries of the cranium and pelvis. Great mischief is sometimes inflicted upon the osseous tissue by mere contusion or concussion, as when a bone is struck by a glancing ball, a kick, or a fall.

1st. *Incised Wounds.*—Incised wounds, properly so called, of the osseous tissue, are uncommon. The most remarkable example of the kind that I have ever witnessed occurred in a man, thirty-nine years of age, from a cut with a butcher-knife, which completely severed the ulna at its junction with the olecranon process. The wound extended from behind forward, dividing the osseous tissue as smoothly as if it had been a perfectly soft substance, laying open the joint freely at its posterior surface, and for a time bleeding quite profusely. The treatment was conducted upon general principles, and in less than eight weeks the union was complete. The elbow, however, remained permanently ankylosed.

Incised wounds from accident occur, perhaps, more frequently in the bones of the hand and fingers than in any other pieces of the skeleton. Laborers in chopping wood often meet with such injuries, and it is not surprising, when we consider the vascularity of the parts, that they should sometimes be attended with very serious hemorrhage.

In sword and sabre wounds, portions of bone, occasionally of considerable size, are liable to be sliced off, sometimes completely, at other times partially. In the latter case, the fragment retains its attachment either by osseous tissue alone, or, as is more generally the case, by osseous tissue and soft structure.

Wounds made with the sword partake of the character of incised and contused wounds: the osseous tissue is more or less bruised by the motion of the vulnerating body, and necessarily unites more slowly than in an ordinary simple cut.

The treatment is by apposition and rest of the parts, maintained uninterruptedly until there is complete union, as there generally will be in from three to five weeks, according to the extent of the wound, the condition of the system, and the absence of complications. In incised wounds in which a portion of bone is sliced off, but still retains some of its attachments through the soft parts, the flap should immediately be replaced, and confined by sutures, plaster, and bandage. When, on the contrary, the separation is complete, reunion could hardly be expected, although the attempt might not be unworthy of trial. When a small bone, as a digital phalanx, is entirely cut through, the ends may very properly be connected with silver wire, the more especially when there is more than ordinary difficulty experienced in keeping the parts in place.

2ndly. *Contused Wounds.*—In this variety of injury, the osseous tissue is, as the name implies, not only denuded, but more or less bruised, compressed, or condensed by the forcible approximation of its component elements. The lesion is strictly analogous to a contused wound of the soft structures. The most common causes of such an occurrence are blows, falls, kicks, and gunshot violence, especially that variety of it in which the force of the bullet is in great measure spent before it reaches the bone. A bone may be severely bruised without any wound either of its own substance or even of the skin. Such an injury falls properly under the denomination of a contusion. A simple fracture, as it is called, affords a good illustration of the amount of injury which a bone may sustain without any serious participation of the soft structures.

A bruise of the osseous tissue, however slight, is always attended with rupture of the vessels of the part, and, consequently, with more or less effusion of blood, occupying its cells, and thus compressing its substance. When the infiltration is considerable, it must necessarily act as a foreign agent, exciting inflammation, which, if not kept within proper limits, may eventuate in suppuration and even gangrene. Another serious effect of such a lesion, especially if it is at all severe, is the immediate destruction of the vitality of the affected tissue, from the arrest of its circulation and innervation. The component elements are fatally compressed, being placed in a condition similar to that of a soft structure in a bruised and pulpified state. In both instances death occurs without inflammation. In general, however, this action is set up, and finally terminates either in resolution, suppuration, or gangrene. If the injury is severe, its effects will not be likely to be limited to the bone, but extend also to the periosteum, to the medullary membrane, and even to the muscles and other textures. Osteitis, periostitis, and endosteitis, indeed, are by no means uncommon after such accidents; large pieces of bone sometimes perish in this way, and the patient, after passing through intense suffering, both local and constitutional, may consider himself happy if he escapes with limb and life. The morbid action is excessive; the soft parts are enormously swollen from inflammatory deposits; the pain is agonizing; the skin exhibits an erysipelatous blush; and there is high general excitement, with a tendency to delirium and rapid prostration. Matter forms in large quantities both within the medullary canal, in the osseous tissue beneath the periosteum, and among the muscles, and, if not speedily evacuated, is apt to diffuse itself more or less extensively through the surrounding structures. Such cases are often followed by death from constitutional irritation and hectic fever. The worst attacks may end fatally in a few days. The danger is always imminent when the contusion involves the articular extremity of a large joint, as the knee, hip, or ankle.

Among the more remote secondary effects of contusion of the osseous tissue is interstitial absorption, leading to atrophy and change of form of the affected structures, as is exemplified in interstitial absorption of the head and neck of the thigh-bone after severe contusion, or contusion and concussion of the great trochanter from falls and other injuries upon the thigh and hip.

Even a very slight contusion, if a bone, as the tibia, ulna, clavicle or cranium, is only thinly covered, is sometimes followed by severe local and constitutional symptoms; the inflammation is prone to assume an erysipelatous character, and to give rise to subperiosteal abscesses, attended with great pain and swelling. In elderly subjects, contusion of the osseous tissue often gives rise to atrophy and various ossific deposits.

The diagnosis of contusion of the osseous tissue is often very difficult. Indeed, in many cases it is purely a matter of conjecture, based upon the condition of the parts, as the discolored and bruised appearance of the skin, the existence of ecchymosis, and the peculiar character of the secondary symptoms. When the bone is laid bare by the accident, the true nature of the case is often perceptible at a glance.

The prognosis should always be guarded; for, as previously stated, even an apparently insignificant injury of this kind is sometimes followed by loss of limb, if not also by loss

of life. When the lesion is very severe, the worst results may be anticipated, either proximately or remotely, the most common sources of danger being shock, erysipelas, pyemia, and hectic irritation.

In the treatment of this variety of injury, the ordinary means must be adopted for counteracting inflammation and its consequences. Leeches and saturnine lotions will be needed in the earlier stages, and afterwards free incisions to relieve pain and tension, and afford vent to the pent-up deposits. Dead bone is removed as soon as it is sufficiently detached. If symptoms indicative of the existence of abscess of the affected bone arise, recourse is had to the trephine. Amputation will be likely to be demanded when one of the principal joints has been laid open, or when, along with severe contusion, there is a comminuted fracture, serious lesion of the soft parts, or a wound of the main artery, veins, or nerves of the limb.

3rdly. *Lacerated, Punctured, and Gunshot Wounds.*—The best example of a lacerated wound of a bone is an ordinary fracture, in which the osseous fibres are forcibly torn asunder. The injury is essentially similar to a lacerated wound of the soft structures. Such a lesion may be perfectly simple as it respects the osseous tissue, or this tissue may be torn into fragments, of variable shape and size, constituting what is known as a comminuted fracture. The soft structures may be little implicated, or they may be more or less extensively bruised and lacerated, and in this way a case, in itself comparatively unimportant, may assume a most serious character, placing limb and life in jeopardy.

Punctured wounds are generally caused by bullets, and will be serious or otherwise, according to the shape and size of the projectile, the force with which it is impelled, and the importance, as a protective organ or an agent of locomotion, of the part struck. Punctured wounds of the skull, for example, however inflicted, are always fraught with danger, inasmuch as the inner table is almost invariably more or less depressed, and thus brought injuriously in contact with the brain and its envelops, leading to suppuration and other mischief. Punctured wounds of the long bones, especially such as are caused by gunshot violence, are generally attended with comminution of the osseous structure, and are to be regarded as among the most serious of accidents, liable to be followed by loss of limb and life. Even the milder forms of such lesions are often productive of the worst consequences, the primary effects being osteitis, periostitis, or medullitis, and the secondary suppuration, abscess, or necrosis.

The vulnerating body in a punctured wound either lodges in the bone, or it perforates the bone and then either makes its escape or buries itself in the soft structures. The edges of the opening of entrance in a gunshot wound are generally somewhat depressed, whereas the edges of the orifice of exit are always more or less ragged and irregular. In fact, there is the closest resemblance, in these respects, between a gunshot wound of a bone and a similar lesion of the common integument.

In regard to the treatment of these several classes of wounds, nothing need be said here, as it is discussed at sufficient length in the chapters on gunshot injuries, fractures, and other lesions.

2. *Wounds of the Periosteum.*—Simple incised wounds of this membrane are of little moment; for, if properly managed, they either unite by the first intention or they are speedily repaired by the granulating process. Suppuration and gangrene seldom occur, except in persons of dilapidated health, or when the lesion is associated with more or less contusion, or contusion and laceration. Ordinary punctured wounds also generally readily heal; gunshot wounds, on the contrary, are often followed by violent inflammation, extensive infiltration of pus, and even devitalization, not only of the membrane itself, but also of the corresponding portion of the bone and of the endosteum. A severe contusion, such, for example, as that caused by the glancing of a musket-ball, or by a blow, fall, or kick, is always a grave accident, especially if the periosteum is partially detached; for then suppuration of the membrane, if not also necrosis, will be almost sure to ensue from the disruption of the circulation and innervation of the part. Even a slight contusion of this membrane, if thinly covered, as in the tibia and ulna, may cause severe erysipelas and other troublesome inflammatory symptoms.

It is generally believed that when a bone is deprived of periosteum it must necessarily perish; but this is so only when the loss is very considerable. Ordinarily the part retains its vitality, granulations gradually spring up, and ultimately the breach is repaired by the formation of an analogous tissue, not so perfect, indeed, as the original, yet sufficiently to answer the purpose of a substitute covering. When the denudation is extensive, death is inevitable; for then the osseous tissue is deprived both of blood and nerve fluid, and, consequently, dies from the want of nourishment. The effect thus produced closely

resembles senile gangrene, the result of obstruction of the vessels by fibrinous concretions. In some cases the death of the affected bone is direct, that is, it takes place without the intervention of inflammation; in general, however, a slight action of this kind is set up, but soon terminates in gangrene, the osseous tissue being incapable of furnishing pus and of undergoing the various changes which ordinarily precede the occurrence of necrosis.

The most common cause of denudation of bone is external violence. In compound fractures attended with protrusion of the ends of the fragments, the periosteum is often extensively stripped off, and the consequence is that the part, unless speedily replaced, soon perishes. Great mischief is frequently inflicted upon this membrane by the saw in amputation. The femur, in particular, is remarkably prone to suffer from inflammation from this cause, as is proved by the immense exfoliations which sometimes occur after this operation. A bone is occasionally completely stripped of its fibrous covering by an accumulation of pus between the two opposed surfaces, in consequence of periostitis and osteitis.

Owing to the important rôle which this membrane plays in the nourishment and preservation of the osseous tissue, the utmost care should be taken to keep it intact in surgical operations, and to place it in the most favorable position for speedy reunion in cases of injury. Not a particle, unless it is absolutely dead, should be cut away. If any portion has been accidentally torn off, the denuded bone should be promptly covered with the natural tissues in its immediate vicinity, or, in the event of their loss, with an emollient poultice, to protect the exposed surface from the contact of the air, and thus afford it a chance to develop granulations. If matter form beneath the periosteum, it cannot be too speedily evacuated, on account of the danger to the corresponding bone. In the milder forms of contusions leeches and saturnine lotions are the most reliable means.

3. *Wounds of the Endosteum.*—Wounds of the endosteum, medulla, or marrow, can occur only in connection with similar lesions of the periosteum and osseous tissue, its peculiar situation precluding it from being injured by itself. The most common causes of such wounds are fractures, blows, falls, and kicks, and operations performed for the relief of disease either of the soft parts or of the bones, as amputations and resections. Among the more severe forms of wounds of the endosteum are compound, comminuted fractures from gunshot injury, laying open the medullary canal, lacerating and bruising the lining membrane, and shattering the osseous tissue into numerous fragments. Very serious injury is sometimes inflicted upon this membrane by the concussion of a bone produced by being struck by a partially spent ball, the effect being analogous to that inflicted upon the brain and its membrane when a person receives a blow upon the skull. The bone itself may in reality be very little hurt, and yet the shock transmitted across the osseous fibres be sufficient to light up violent morbid action.

The effects, immediate and remote, of wounds of the medulla, must necessarily vary with many circumstances, as the character and extent of the lesion, the presence or absence of complications, and the state of the system at the time the injury was received. Owing to the vascularity of the membrane, there is often a good deal of blood effused, the pressure of which may afterwards provoke more or less inflammation. Sometimes this is the case when the amount of fluid is extremely small, as when it presents itself simply as an ecchymosis. When the medullary canal is extensively exposed, the hemorrhage may be quite profuse, especially if the endosteum is extensively lacerated and detached. The resulting inflammation may, on the one hand, be very slight; or, on the other, so violent as to pass rapidly into suppuration and even gangrene, not only of the membrane itself, but also of the corresponding portion of the bone and of its fibrous envelop. Such cases are generally attended with severe constitutional disturbance, as well as much local suffering; the soft parts are the seat of erysipelas; and the system, especially if not in a sound condition at the time of the infliction of the injury, is very prone to be invaded by pyemia. The marrow, if exposed to the contact of the air, will be found to be, at first, of a pale violet hue from vascular congestion, and afterwards of a grayish, brownish, or ashy color, softened, diffluent, excessively fetid, and bathed with pus or sero-oleaginous fluid. The bone around is dead, the periosteum is detached, and the muscles and other tissues in the neighborhood of the disease are in a high state of inflammation.

The treatment must be conducted upon the same principles as in wounds of the bones and periosteum. The parts must, if possible, be placed in their natural relations, and every effort made to limit the morbid action. The hemorrhage may generally be checked by compression with a soft pledget of lint, sponge, or agaric, retained by the finger, until the flow ceases. All irritating applications must be avoided, as likely to excite undue

inflammation.   A free outlet should be formed for matter, and dead bone should be removed as soon as it is sufficiently detached.

SECT. II.—PERIOSTITIS.

The occurrence of periostitis is by no means infrequent, its causes being those of osteitis, with which, especially in its acute form, it is usually associated.   Among the most common of these causes are various kinds of external injury, as fractures and dislocations, blows, contusions, gunshot wounds, and the application of escharotic substances ; and the effects of gout, rheumatism, and syphilis, operating upon a disordered and dilapidated state of the system.   There is one form of whitlow which is essentially a periostitis, attacking usually one of the fingers, and liable, if neglected or improperly treated, to terminate in extensive suppuration and necrosis of the distal phalanx.   Inflammation of the periosteum, of a very severe and destructive nature, is occasionally produced by deep-seated abscesses, extending to, and irritating that membrane, as sometimes happens, for example, in phlegmonous erysipelas, where the matter burrows extensively among the surrounding tissues. Two forms of the disease are met with, the acute and chronic, the latter being the more common.

Acute Periostitis.—In the acute form of inflammation, the fibrous membrane is commonly of a reddish, pink, or lilac hue, its vessels are loaded with blood, and its substance is sensibly softened, as well as slightly thickened from interstitial deposits.   Its attachment to the bones is also considerably diminished, so that it may readily be peeled off, and the connective tissue immediately over its outer surface is generally infiltrated with sero-albuminous matter.   These changes, which are present, in greater or less degree, in all cases of periostitis, are often very conspicuous upon the fragments of a broken bone, and in incised wounds of the muscles, involving the membrane in question.

The disease not unfrequently passes into suppuration, the occurrence being particularly liable to happen in the periosteum of the bones of the inferior extremity, as the femur and tibia, and in the phalanges of the thumb and fingers ; in the former as a consequence of cold acting upon a strumous constitution, or of the effects of mercury, or of mercury and syphilis, and in the latter as a result of whitlow.

Abscesses of the periosteum are of two kinds, the circumscribed and the diffused.   Of the former familiar examples are seen in the jaws, in what is called a gum-boil, and in the ends of the fingers in whitlow.   A syphilitic node affords another illustration of such an occurrence, so frequently witnessed in the tibia, clavicle, cranium, and other superficial pieces of the skeleton.   The matter in this variety of abscess is ordinarily very thick, of a pale yellowish or yellow-greenish color, deep-seated, and of rapid formation.   The periosteum at the focus of the morbid action is spongy, swollen, congested, and infiltrated with sero-sanguinolent fluid, and the corresponding portion of the bone is in a carious or necrosed condition.

The diffused abscess of the periosteum is a most formidable disease, generally proceeding with extraordinary rapidity, and often committing the most frightful ravages in a few days.   It usually occurs in young subjects under fifteen years of age, of a scrofulous or syphilitic taint of the system.   Its most common sites are the femur and tibia, which are not unfrequently almost completely stripped of their fibrous covering.   The matter, which often forms in enormous quantities, is thin, bloody, fetid, and intermixed with flakes of lymph, clots of blood, and the débris of disintegrated tissue.   The nearest joints in these violent cases usually participate in the disease ; the synovial membrane becomes inflamed ; and, if great care be not taken, ankylosis ultimately ensues.   The bone and endosteum are always seriously involved in the mischief.

A violent form of periostitis not unfrequently supervenes upon injury of the skull, especially in punctured and contused wounds, and is very prone to terminate in extensive suppuration, the pus lifting up the pericranium from the bone, which looks white, grayish, or drab-colored, and often perishes from the effects of the disease.   In lying-in women violent periostitis sometimes occurs as a secondary affection in the iliac bone, near the hip-joint ; the suffering is excessive, and the affection is very liable to be mistaken for coxalgia, the more so, as it sometimes passes into suppuration.   Inflammation of the periosteum over the great trochanter is also apt to be confounded with coxalgia, and is often followed by abscess, caries, and even necrosis of the upper portion of the femur.

Mortification, as a termination of this disease, is uncommon.   The occurrence is characterized by a dirty, ash-colored appearance of the affected membrane, which is, at the same time, very much softened in its texture, and saturated with a foul, offensive fluid, emitting

an unmistakably gangrenous odor. Such an event is necessarily associated with necrosis of the corresponding bone, and frequently, also, with mortification of the endosteum, all perishing together in consequence of the destruction of their vascular connections. The best examples of this mode of termination occur in the periosteum of the alveolar processes of the jaws, from the abuse of mercury, and in that of the tibia, from the effects of syphilis. The sloughs, which are always tough and shreddy, are usually thrown off with considerable difficulty, owing to the tardy and imperfect action of the circumjacent structures.

The *symptoms* of periostitis are similar to those which usually attend inflammation of the deep-seated structures generally, the pain being of a violent and pulsatile character, and the swelling of the soft parts diffused and œdematous, with excessive heat of surface, and more or less constitutional disturbance. The occurrence of suppuration is announced by rigors, with a marked increase of local suffering; and as the pus accumulates, the superincumbent integument assumes a shining, glossy, erysipelatous aspect, pitting under pressure, and imparting a distinct sense of fluctuation. Both in suppuration and mortification the pain is intense, and the patient generally labors under high fever and often also under delirium. If relief be not speedily afforded, hectic irritation sets in, and death may occur from sheer exhaustion. The danger from pyemia is always great in such cases.

In periostitis consequent upon a syphilitic taint of the system, the suffering is always worst at night, the pain being of a severe, aching, or gnawing character, and invariably aggravated when the patient becomes warm in bed. Small, circumscribed swellings, or nodes, frequently exist, and are exquisitely tender on pressure and motion, the skin over them being red, inflamed, and œdematous. The contents of these swellings are generally of a thick, gummy character, possessing none of the properties of genuine pus.

In gouty and rheumatic periostitis the pain is deep-seated, wandering, or migratory, and generally very severe; the soft parts over the seat of the disease are discolored, glossy, and puffy; slight effusions of sero-plastic matter often exist beneath the affected membrane, forming small, rough, and irregular swellings, which are easily detected by the finger; the system is disordered by fever; the perspiration is acid and copious; and the urine is scanty and high-colored, depositing a large quantity of lateritious substance upon the bottom of the receiver. The most reliable symptoms, in a diagnostic point of view, are, the shifting character of the disease, the involvement of the joints, and the history of the case.

In the *treatment* of acute periostitis, a primary object is to seek for, and, if possible, to remove, the cause of the disease. The traumatic form is to be managed upon ordinary principles. Idiopathic periostitis is often a self-limited affection, tending to terminate in suppuration, despite the best directed efforts of the surgeon. Examples of this constantly occur in whitlow and in some varieties of necrosis, in which periostitis commonly plays an important part, the morbid action being apparently dependent rather upon some inscrutable constitutional trouble than any special local cause. General treatment can seldom be altogether dispensed with, while in many cases it constitutes our most valuable resource, no progress of a favorable character being made without it. In the more severe forms, bloodletting, active purgatives, and saline and antimonial preparations, will probably be required, along with anodynes, to allay the excessive pain which is so often present. The most important topical remedies are leeches, iodine, blisters, and saturnine lotions with laudanum. If great tension exist, with a tendency to suppuration, deep incisions are made without waiting for fluctuation, which is often extremely difficult of detection, unless the affected structure is very superficial, as, for example, in periostitis of the tibia. The necessity of this operation cannot be too strenuously insisted upon, as it is the only way in which we can afford prompt relief to the suffering, and obviate extensive and irremediable mischief, as must inevitably happen when the matter is permitted to burrow. After evacuation has been effected, the sides of the abscess should be brought together with a compress and bandage, otherwise copious hemorrhage may arise in consequence of the crippled and enfeebled condition of the vessels, and finally destroy the patient. When mortification takes place, the same treatment must be adopted as under ordinary circumstances.

In all the more violent forms of diffused abscess, antiphlogistics, if eligible at all, must soon give way to stimulants and tonics. The system, exhausted by the intensity of the suffering, must be supported with milk-punch, quinine, iron, and opium, in full and sustained doses. Great attention must be paid to cleanliness, the air of the apartment must frequently be renewed, and the cavity of the abscess must be injected several times a day

with weak solutions of carbolic acid, chloride of zinc, permanganate of potassium, or chlorinated sodium. During convalescence, cod-liver oil often proves serviceable.

In syphilitic periostitis the best remedy is some one of the iodides, in doses of five to ten grains three times a day, either alone or in union with bichloride of mercury. If nodes form, they will generally disappear under the influence of tincture of iodine, blisters, or mercurial inunctions, interference with the knife being seldom demanded.

Periostitis caused by rheumatism and gout requires the use of colchicum, Dover's powder, or Dover's powder and quinine, with systematic purgation, and occasionally, perhaps, slight ptyalism, with leeches, fomentations, and alkaline and anodyne liniments.

Chronic Periostitis.—The periosteum, in chronic inflammation, is thickened and indurated from the effusion of plastic matter. The hypertrophy—for so it may be termed—often involves a considerable extent of surface, forming a diffused, incompressible swelling, fibrous, cartilaginous, or even osseous in its character. Sometimes, on the other hand, the enlargement is very small and circumscribed, not exceeding, perhaps, the end of the little finger or half a dime. It may be caused by some specific constitutional poison, especially the syphilitic, or by external violence, as a blow, fall, or kick, as is often the case when it exists on the skull. However induced, its development is attended with a constant, deep-seated, gnawing pain, which is usually most severe at night when the body becomes warm in bed, and which occasionally assumes a veritable neuralgic character. After continuing for an indefinite period, the disease often remains stationary, gradually disappears, or excites suppuration in the overlying tissues.

These chronic affections of the periosteum are generally peculiarly obstinate and intractable, requiring specific remedies, frequently varied and long continued, for their cure. Iodide of potassium and mercury, Donovan's solution, and the different preparations of arsenic, with blisters, iodine, leeches, the vapor bath, and mercurial fumigations, are the means most likely to prove beneficial. In obstinate cases, resisting the ordinary remedies, free incisions, extending through the substance of the thickened and indurated membrane down to the bone, will afford more relief than anything else, especially if the wound be made to suppurate abundantly.

Bony tumors, growths, or deposits of this membrane, are to be treated upon the same principles as exostoses, properly so termed. When small, not painful, or not inconveniently situated, they will probably require no attention. Occasionally they disappear spontaneously, or under the influence of very simple remedies. Such formations are nearly always caused by the effects of the gouty, rheumatic, or syphilitic poison, and are, therefore, generally greatly benefited by iodide of potassium and a mild course of mercury.

Finally, the periosteum is sometimes the seat of the morbid growths, as the sarcomatous and fibrous, affections which will be discussed in the section on tumors of the bones.

NEURALGIA.

Neuralgia of the periosteum, as a simple, uncomplicated affection, is infrequent. The most common exciting causes are, external injury, as a bruise or contusion, miasm, sudden suppression of the cutaneous perspiration, and a syphilitic taint of the system. Any portion of the skeleton may suffer from it, but the parts most frequently assailed are the cranium, clavicle, ulna, ribs, and tibia, bones which are comparatively superficial, and which, apparently for this reason, are particularly prone to exposure and accident. I have repeatedly met with severe neuralgia in the pelvic bones, and a peculiarly obstinate form of the disease, known as coccydynia, is occasionally witnessed in the coccyx. The affection is generally associated with neuralgia of the osseous tissue, and is not confined to either sex or to any particular period of life. What influence, if any, temperament may exert upon its production is undetermined.

The characteristic symptom is violent pain, generally limited to some particular bone or portion of bone, occupying a space not larger, perhaps, than two or three inches in extent; either sharp and darting, or, as more frequently happens, dull, heavy, and aching, increased by pressure, motion, and dependency, commonly worst at night and in damp states of the atmosphere, especially when the cause is syphilitic. The pain usually remits several times in the twenty-four hours, and cases occur, as when it is of miasmatic origin, in which it is distinctly periodical, the attack occurring with the same regularity as a paroxysm of intermittent fever. However this may be, the parts are always exquisitely sensitive on pressure, with a feeling of weight and numbness; and pain, of a severe character, is not unfrequently experienced along the course of some particular nerve. There is no discoloration of the surface, or hardly ever any decided tumefaction. The general

health, at first perfectly normal, is gradually impaired, and, in the more severe cases, ultimately completely ruined.

Of the precise nature of this complaint nothing is known. It is probably, in the first instance, merely an affection of the nerves; but, as the disease progresses, other structures become involved, until, eventually, inflammatory deposits are superadded, as is shown by the thickened, spongy, and congested condition of the periosteum and the roughened appearance of the corresponding portion of the bone.

The diagnosis of this disease is not always very clear. The great trouble generally is to determine whether the morbid action is seated in the periosteum or in the bone which it covers. Practically, the distinction is of little moment, as the treatment is the same in the two complaints. The disorder, which often coexists with neuralgia in other parts of the body, is usually exceedingly obstinate and difficult to cure.

The treatment must be regulated with special reference to the nature of the exciting cause of the complaint. The most reliable internal remedies are quinine, iron, strychnia, arsenic, and aconite, either alone or variously combined, with an occasional laxative to regulate the bowels and secretions. The iodides will be required when the disease depends upon a syphilitic taint of the system. The best local applications are leeches, blisters, veratria ointment, iodine, lotions of chloroform and aconite, and hypodermic injections of morphia and atropia. In obstinate cases, attended with thickening of the periosteum, or organic disease of this membrane and the bone, nothing short of deep and extensive incision will be likely to do any good.

SECT. III.—ENDOSTEITIS, MEDULLITIS, OR OSTEOMYELITIS.

Under this name may be described a disease of the endosteum or medullary membrane, possessing all the characters of true inflammation, either acute or chronic, invariably coexisting with osteitis, and presenting itself in two distinct varieties of form, the idiopathic and the traumatic. The former, like osteitis, is most common in children and young subjects before the age of puberty, and the tibia and femur are the bones that most frequently suffer. How this variety of the disease originates is not always easy of determination. In the great majority of the cases that have come under my observation, the immediate exciting cause seems to have been cold, or sudden suppression of the cutaneous perspiration, operating upon a weak, delicate constitution. Occasionally the affection depends upon some peculiar taint of the system, as the syphilitic, strumous, or scorbutic, provoking inflammation consentaneously in the endosteum, osseous tissue, and periosteum.

The most common traumatic causes are fractures, gunshot wounds, the lodgment of foreign bodies in the substance of the bones, violent blows, contusions, concussion of the spongy tissue, and laceration of the endosteum by the saw in amputation of the limbs, of which the lesion is by no means an uncommon consequence, as is shown by the suppuration and necrosis which so often follow this operation. There can be little doubt that the disease is frequently produced by mere concussion of the limbs, transmitting its injurious effects along the canals of the long bones, thereby, perhaps, partially detaching portions of the lining membrane, and inducing serious disruption of the circulation.

The morbid anatomy of the disease is best studied in one of the long bones, as the femur or tibia, after amputation. If several days have elapsed since the operation, the membrane will be found to be of a pale pink hue, more or less injected, and apparently a little thickened; the marrow is abnormally soft; and the cells of the spongy structure of the canal are pervaded by a sero-sanguineous fluid. At a later period, when the inflammation is more fully established, the discoloration of the endosteum is of a more decided character, being of a deeper red with a shade of brown or purple, the fatty matter is broken up into a semiliquid substance, and, in addition to the bloody sanies just alluded to, traces of pus may be seen, forming numerous little points, of a yellowish aspect, which, gradually coalescing, at length assume the character of small abscesses. When the disease is uncommonly violent or protracted, portions of the endosteum are converted into veritable eschars, of a brownish color, and of a characteristically fetid color; the periosteum opposite the seat of the morbid action is detached, and the intervening part of the bone, thus deprived of its vessels, speedily perishes.

In the chronic form of the disease, which sometimes lasts for years, the osseous structure is rendered abnormally hard, dense, and heavy, the medullary canal is in great measure, if not entirely, obliterated, and the endosteum, at the seat of the morbid action, is completely destroyed. Small cavities filled with a soft, oily material, or fatty, gelati-

nous substance, and surrounded by softened, vascular, reticulated tissue, are not unfrequently found ; and cases are occasionally met with in which there are small abscesses and dead pieces of bone.   When the disease is of long standing, the affected bone is always more or less changed in its form, rough on the surface, and remarkably thickened, compact, and heavy ; in fact, greatly hypertrophied by the addition of new matter.

The *symptoms* of endosteitis are so vague and unreliable as to render it very difficult, if not impossible, to distinguish them from those which attend inflammation of the bones and their fibrous envelop.   Indeed, it is only when the disease occurs as the result of injury, as after amputation, that anything even like a plausible conjecture can be formed as to its real nature.   Under such circumstances, upon taking off the first dressings, the wound opposite the end of the bone will probably be found to be gaping and filled with pus, the bone itself being either entirely denuded, or only slightly covered with lymph below, while the medullary membrane is of a reddish or brownish color, and more or less vascular.   If six or eight days have elapsed since the operation, the exposed medullary surface will be likely to be studded with pale, flabby, unhealthy granulations, somewhat sensitive to the touch, if not decidedly painful, and discharging an abundance of thin, sero-sanguinolent fluid.   Around this red and inflamed circle, the compact layer exhibits an unusually white, glistening appearance, without any trace of reparative action ; in fact, the bone is devitalized, or, if not actually dead, soon will be.   Superadded to these phenomena, there is occasionally an escape of marrow, with or without fragments of the medullary membrane ; a sure sign of the inflamed and disorganized state of the parts.

Endosteitis is always attended with considerable swelling and puffiness of the soft structures immediately over the affected parts, but there is not necessarily any discoloration of the surface, or any unusual pain.   Considerable irritative fever is commonly present ; the skin has a peculiar sallow hue ; and there are apt to be rigors, alternating with flushes of heat, and followed by copious sweats, generally of a disagreeable acid nature.   When the disease is idiopathic, there may be tumefaction and pain, deep-seated and throbbing, at the site of inflammation, but neither of them of so distinctive a character as to be of any service in a diagnostic point of view.

However induced, or in whatever form occurring, the disease generally manifests a disposition to affect the contiguous joints, being apparently propagated from the cancellous structure to the synovial membrane.   The form in which the articular affection usually appears is that of a moderate degree of inflammation, attended with more or less effusion of synovial fluid, or of this fluid and of plastic matter, and a certain degree of pain and functional disturbance, so constantly present in disease of the joints.   When the malady is uncommonly severe, the articular structures generally suffer in a proportionate degree ; for then not only the synovial membrane, but also the end of the bone and its cartilaginous covering participate in the morbid action ; abscesses are liable to form both within and around the affected joint ; the soft structures are enormously swollen ; the skin has a glossy, erysipelatous appearance ; and there is excessive constitutional disturbance, rapidly followed by hectic fever.   If the case is not properly treated, the pus may burrow extensively among the surrounding parts, giving rise to numerous sinuses, which it will be difficult, if not impossible, to heal.   The joints that are most liable to suffer in this way are those of the knee and ankle, especially the former.

In the idiopathic form of endosteitis of young subjects the epiphyseal fibro-cartilage not unfrequently suffers, becoming inflamed, and, in the more severe cases, the seat of purulent depots.   Now and then the connection is entirely destroyed, the head and shaft of the bone being detached from each other as completely as in diastasis.

The danger in endosteitis is generally very great, as it is liable, if the disease is at all severe or wide-spread, to cause extensive necrosis, and to place limb and life in peril by the induction of inflammation in the principal veins of the corresponding extremity and the formation of abscesses in the different viscera, especially the lungs and liver.   Occasionally, it would seem to be capable of assuming a kind of endemic tendency.   Thus, in 1814, nearly all the patients at the Hotel-Dieu, in Paris, who died after amputation, and the number was very considerable, were observed to have suppuration in the medullary membrane of the long bones.

The *treatment* of endosteitis must be conducted upon general antiphlogistic principles, local and constitutional, in the hope of limiting morbid action and preventing the occurrence of suppuration and gangrene.   If the medullary canal is exposed, some mildly stimulating injection, such as a very weak solution of nitrate of silver, tannic acid, or acetate of zinc, may be useful, the part being protected from the atmosphere by lint wet with a similar fluid, or an emollient cataplasm.   When the membrane is affected in its con-

tinuity, and there is much swelling of the soft structures, free incisions may be necessary in order to relieve tension and promote the escape of the effused fluids. If there is reason to apprehend the existence of medullary abscess, as when there is deep-seated, aching, gnawing, or boring pain, with œdema of the subcutaneous connective tissue, the matter must be exposed with a small trephine, as the only chance of averting still more serious consequences.

In the strictly chronic form of the disease, our chief reliance is upon iodide of iron and iodide of potassium, with minute doses of bichloride of mercury, tonics, cod-liver oil, change of air, and counterirritation. In the more hopeless cases it may be necessary to trephine the affected bone, or even to resort to amputation.

SECT. IV.—EPIPHYSITIS.

Under this appellation may be briefly described an affection which, commencing in the osseous tissue, the periosteum, or the medullary membrane, gradually extends to, and eventually expends itself chiefly upon, the soft pulpy, vascular fibro-cartilage between the epiphysis and the shaft of a bone. This substance, which performs a most important rôle in the growth of bone, does not entirely disappear until the completion of the ossific process, about the close of the twenty-fourth year. Its main object seems to be twofold: first, to serve as a bond of connection, and, secondly, to assist in maintaining the circulation in the two pieces of bone between which it is situated.

Epiphysitis is essentially a disease of early life, the great majority of cases occurring before the tenth year. Although occasionally arising spontaneously, it is ordinarily caused either by suppression of the cutaneous perspiration or by external injury, as a sprain, blow, or contusion. Children of a strumous, scorbutic, or syphilitic taint of the system, ill-fed, pale and anemic, are its most common subjects. Sometimes it would seem to have a rheumatic origin. The attack may be primary, beginning in the epiphysary structure, but this is unusual. In the great majority of cases it is, as already stated, propagated from the neighboring tissues. However this may be, the affection is generally of an acute character, and runs its course with extraordinary rapidity and violence.

The pieces of the skeleton which are most liable to suffer are the femur, tibia, humerus, ulna, and radius, the relative frequency being in the order here stated. Of 13 cases observed by Dr. Klose, 7 affected the femur at the knee, and 4 the tibia, of which 3 involved the superior epiphysis. From the fact that so many cases of this disease were observed by one surgeon, it may be inferred that it is very frequent in Germany; in this country, on the contrary, it is very uncommon, or, if not uncommon, it has not hitherto been accurately discriminated.

The approach of the disease is generally announced by febrile disturbance, if not by a severe rigor, and by violent pain, often apparently of a rheumatic nature, in the situation of an epiphysis, in the immediate vicinity of a joint. The affected part, hot and tender, pits on pressure, but, except in rare cases, there is, as yet, no decided redness of the skin. The contiguous joint, which always participates in the morbid action even at an early period of the attack, is stiff, semiflexed, and exquisitely sensitive upon the slightest motion. In the more severe cases, there are cord-like indurations below the affected surface, evidently caused by inflamed veins and lymphatic vessels; and, if an exploring needle be introduced, it will be found that the bone is roughened and separated from the periosteum by a thin, turbid fluid. If the disease be not checked, it will gradually run into suppuration; the matter is deep-seated, and, unless promptly evacuated, will diffuse itself extensively among the surrounding structures, separating them from each other, and thus occasioning irreparable mischief. Finally, the connecting medium is completely destroyed, and the ends of the two pieces of bone may be seen and felt beneath the skin as in a common fracture. The local and constitutional symptoms are proportionately severe. The pain and swelling are excessive, the surface is covered by an erysipelatous blush, the limb is perfectly useless, and the system is exhausted by hectic irritation and profuse sweats.

The diagnosis of epiphysitis is generally very difficult. The affections with which it is most liable to be confounded are periostitis, osteitis, and endosteitis, from which it is often impossible to separate it, especially in its earlier stages. When the epiphysary fibro-cartilage has been completely destroyed, the preternatural mobility, crepitation, and displacement of the extremities of the bone will sufficiently indicate the nature of the complaint. An error of diagnosis is the less to be regretted, because the treatment of these different maladies is essentially similar.

If the patient dies in the second stage of the disease, the ends of the bones will be found to be soft and spongy, and soaked in thin, ichorous matter, the line of demarcation between them being indicated by a deep groove. The muscles are of a dark brownish color, isolated, and marked by little blackish dots of blood and pus. The veins, large as well as small, are obliterated, and occupied by hard coagula. The contiguous joint contains serum and plasma, but only in very small quantity; for, as yet, its structures are not seriously injured. When the morbid action has reached its maximum, the contents of the abscess are intermingled with clotted blood; the connecting bond at the epiphysis is completely annihilated; the shaft of the bone for a considerable distance is necrotic, denuded of periosteum, bathed in pus, and of a dark, black, or grayish color; the medullary canal everywhere exhibits traces of high inflammation, with unhealthy-looking exudation and a tendency to suppuration; and the neighboring joint, filled with pus, is extensively disorganized, the cartilaginous incrustations being broken down and the ligaments partially destroyed.

The prognosis of the disease may be gathered from its clinical history. If the milder cases occasionally get well, the more severe must, of necessity, be nearly always fatal; or, if not fatal, followed by loss of limb. The great danger is from erysipelas, pyemia, exhaustion, and hectic irritation. Recovery seldom occurs without partial ankylosis of the contiguous joint, and a slight arrest of development of the affected limb, below the epiphysis, the latter of which, as it possesses an independent vitality, continues its accustomed growth.

The treatment must be conducted upon the same principles as in periostitis, osteitis, and endosteitis; by rest and elevation of the part, anodyne and lead lotions, tincture of iodine, leeches, and, above all, early and free incisions, the knife being carried down to the surface of the bone. The system is supported with opium, iron, quinine, and milk punch. In the worst cases amputation alone holds out any hope of saving life.

SECT. V.—OSTEITIS.

Osteitis is a very common occurrence, especially in early life, owing, doubtless, to the great vascularity of the osseous tissue at that period rendering it more susceptible of disease than in old age, when many of the vessels shrink and disappear. It may be primitive or consecutive, acute or chronic; and in either event it may be limited to a particular portion of a bone, or pervade its entire length and breadth, although this is unusual. The spongy tissue suffers more frequently than the compact; and, while in the former, the disease often passes into ulceration, in the latter it more frequently causes necrosis, or mortification, the two structures being evidently endowed with different powers of resisting the effects of inflammation. The pieces most liable to be affected are those which are naturally the least covered by soft substance, as the tibia, fibula, ulna, clavicle, and frontal bone. The disease is generally slow in its progress, and a considerable period may, therefore, elapse before there is any very appreciable alteration of tissue. Cases, however, occur, in which it proceeds with immense and overwhelming rapidity, suppuration, ulceration, and even mortification appearing in less than forty-eight hours from the commencement of the attack.

If a bone affected with inflammation be carefully examined, it will be found to exhibit several important structural changes of great interest. At first it is simply enlarged, although less so than is usually imagined, because much of what appears to be an increase of volume is due rather to swelling of the periosteum than to any actual expansion of the osseous tissue itself. Gradually the affected bone loses its density, becoming softened, and infiltrated with sanguinolent fluid, of a sero-plastic nature, and assuming a bright reddish hue, the capillaries being very numerous, turgid, and distinct. As the disease advances, the osseous fibres separate from each other, and the widened intervals are immediately filled with embryonic tissue, often intermingled with little clots of pure blood. These alterations are always attended by an absorption of earthy matter, which has the effect of rendering the bone both soft and spongy, at the same time that it causes an actual diminution of its weight. The lamellæ of the compact substance are resolved, as it were, into their primitive distinctness, the Haversian canals are greatly enlarged, and the cells of the areolar texture are remarkably rarefied. When the disease has reached its maximum, the osseous tissue is frequently so soft as to be easily bent and cut. When the inflammation is superficial, affecting the outer layers of a bone, it always promptly extends to the periosteum, which, in consequence, becomes red, swollen, and infiltrated with serous and plastic matter. If, on the other hand, the inner structure is

involved, the endosteum is sure to suffer, assuming a discolored, bloodshot appearance, while the adipose matter is either rapidly absorbed, or converted into a soft, diffluent mass, of a light reddish hue, and of a peculiarly fetid character. When the inflammation of the bone is at all extensive, both periosteum and endosteum participate in the morbid action, and it is in these cases, more especially, that, the circulation being cut off by fibrinous exudation, necrosis is liable to arise.

Osteitis may terminate in resolution, the morbid phenomena gradually disappearing, and the affected structures regaining their primitive texture; or the disease may cease, and the bone become indurated and enlarged by interstitial osseous deposits; or, lastly, the inflammation may pass into suppuration, ulceration, softening, or mortification, the results resembling those of inflammation of the soft parts. It is seldom that a bone, after having

Fig. 368.
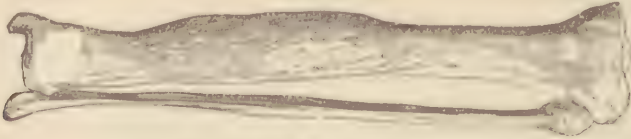
Hypertrophy of the Tibia from Inflammation.

been inflamed for any length of time, will not, upon recovery, remain somewhat hypertrophied, or larger and harder than it was before the attack, as illustrated in fig. 368. It is, in fact, nature's mode of cure, the process which she employs for repairing the mischief committed by the disease.

The causes of osteitis are either traumatic or constitutional, the former consisting of injuries inflicted in surgical operations, fractures, contusions, and wounds, especially gunshot and punctured, and the latter of a syphilitic, strumous, scorbutic, rheumatic, or gouty taint of the system, together with the operation of cold. The disease may begin directly in the osseous tissue, or this may be involved secondarily, from extension of disease from the surrounding parts. Thus, in dislocations, particularly compound, and also in simple dislocations of the larger hinge-joints, as the elbow and knee, the inflammation consequent upon the accident is nearly always communicated to the contiguous extremities of the bones, rendering them soft and brittle, and liable to give way under the slightest influences. In like manner the periosteum often becomes the propagator of the morbid action; for, although, in general, this membrane serves to ward off disease, forming a kind of wall between the soft structures and the bones, yet this barrier is not unfrequently overleaped, and inflammation kindled up in the very centre of these pieces. A great similarity is thus found to exist between the bones, periosteum, and endosteum, on the one hand, and the lungs, pleura, and bronchial mucous membrane, on the other, experience having proved that disease cannot be present in any considerable degree, or for any length of time, in any one of these component elements without being propagated to the rest, which subsequently have often to bear the chief brunt of the incited action.

Although acute osteitis is seldom dangerous, it may, nevertheless, occasionally prove fatal, especially if it be extensive, or complicated with other maladies, by the induction of erysipelas, pyemia, or constitutional irritation. Such an event will be most likely to happen in young scrofulous subjects, or in persons worn out by syphilis. The disease often terminates in serious and irremediable structural disorder of the affected part, as softening, caries, and necrosis, requiring important operations, themselves frequently a source of much risk. Recovery, under any circumstances, is generally extremely tedious.

The *symptoms* of osteitis bear a great resemblance to those of periostitis and endosteitis, and, therefore, the most adroit diagnostician often finds it difficult to discriminate correctly between them. Practically, an error of this kind is of no special moment, as the treatment is essentially similar in the three affections, but as a matter of science it is very desirable in every instance to ascertain, if possible, in what structure the disease is located, or, if all are implicated, in what degree. There is really, however, no one symptom, or group of phenomena, upon which the least reliance can be placed in this respect. It may be said that the pain in osteitis is more intense, agonizing, and deep-seated than in inflammation of the periosteum and endosteum, and yet this is so only as a general rule; in many cases the difference is too slight to be appreciable. The same is true in regard to the swelling of the soft parts, and the constitutional disorders, which are often very great

in all these affections, but, as they do not possess any distinctive features, are of no value in a diagnostic point of view.

Acute osteitis is generally attended by the same symptoms as acute inflammation of the soft structures. The pain is excruciating, the part feeling as if it were torn, or bored, or as if insects were feeding upon it; it is deep-seated, more or less circumscribed, and increased by motion, pressure, and damp states of the atmosphere; it is also usually more violent at night when the patient becomes warm in bed, especially when it recognizes a constitutional origin. The swelling is extensive, firm, and almost inelastic, pitting, perhaps, after a time, under the application of the finger; the skin has a glossy, shining appearance; and there is intense heat of the surface, conjoined, in most cases, with an erysipelatous blush. The constitution sympathizing powerfully with the local disorder, there is high fever, with excessive thirst, a full, bounding pulse, great dryness of skin, and elevated temperature, with all the minor phenomena of general incited action. If the disease is not promptly restrained, the soft parts suppurate, the event being announced by rigors and delirium, followed by copious sweats.

The symptoms of chronic osteitis are usually well marked. The bone is the seat of more or less pain, circumscribed, increased by motion and pressure, and aggravated at night, often depriving the patient of sleep and appetite. Enlargement of the affected part, with swelling and induration of the overlying tissues, is commonly a prominent phenomenon. Eventually suppuration occurs, followed by the formation of sinuses, difficult to heal, and the seat of a constant discharge of thin, ichorous, sanious, or unhealthy matter, occasionally mixed with osseous particles. The constitution frequently sympathizes with the local disorder, as indicated by the pallor of the countenance, the gradual emaciation, and other evidences of failing power.

Palpation and digital percussion have long been employed in the diagnosis of diseases of the osseous tissues, especially in the more superficial bones, as those of the head, back, pelvis, and leg. Although Roux called attention to the subject, we are mainly indebted for our present light to the researches of Professor Lücke, of Strasburg, published in 1877, and comprising a series of valuable and laborious observations upon healthy and diseased bones. Instead of employing the finger, Lücke uses a hammer, consisting of metal tipped with an acorn-shaped point of caoutchouc, and furnished with a whalebone handle, so thin as to vibrate readily under the slightest touch. The percussion should be slight or considerable according to the depth of the bone, or the amount of substance by which it is covered, and successively applied to homologous parts, in order to test their comparative sensibility, otherwise the exploration will be, in great degree, if not wholly, worthless. In examining the limbs, they should be held up and firmly supported by an assistant, to prevent the sounds from being masked by the bedclothes or other material. In inflammation of the osseous tissue, the periosteum, or endosteum, a few smart taps with the hammer are sure to elicit marked tenderness, if not actual pain, and such an exploration is especially valuable in the incipient stages of the affection before the occurrence of serious structural changes. The amount of pain elicited by the percussion will afford a tolerably correct idea as to whether the disease is superficial or deep-seated. Thus, if, on gentle percussion, the patient complain of severe aching pain, and the pain is intensified under a more decided blow, the inference is that the affection is superficial; whereas the reverse is the case if pain be experienced only under forcible percussion.

The character of the sound elicited by percussion presents important variations in health and disease. Lücke has shown that the shaft of a long bone yields a duller resonance under the hammer than its extremity, and also that the sound emitted by a bone is entirely independent of its connection with a neighboring joint, or the surrounding structures. As might naturally be supposed, all inflammatory deposits render the affected bone more or less dull on percussion; and similar effects are produced in chronic osteitis attended with enlargement and condensation of the osseous tissue, as in hypertrophy, hyperostosis, or osteosclerosis. The callus of a broken bone emits a duller sound than the bone in its immediate vicinity. In osteoporosis, in which, as the name implies, the osseous tissue is more or less expanded, a remarkably hollow sound is often produced by percussion.

Obviously such explorations are only applicable in chronic diseases of the bones, and in the earlier stages of the acute form. When acute inflammation is fully established, whether limited to the osseous tissue, or involving also the periosteum and endosteum, the morbid action affects the surrounding structures to such an extent as to render them intolerable of such rude manipulation.

Treatment.—The most important elements in the treatment of osteitis are bleeding, tartar emetic, purgatives, calomel, and opium, with perfect rest both of the part and body.

The prompt abstraction of blood by the lancet, or by leeches from the affected structures, generally proves of marked benefit in abridging suffering and limiting morbid action. Calomel is given as soon as the patient has been properly depleted, and is steadily continued until gentle ptyalism is induced. There is no remedy which exerts so powerful and controlling an influence over inflammation of bone as this; and, although it should not be used causelessly, or without due precaution, there are few cases to which it is not applicable. To prevent it from running off by the bowels, and, at the same time, to mitigate the excessive general and local distress, it should be administered in combination with large doses of opium, repeated as frequently as the exigencies of the case may seem to require.

The best local remedies, apart from leeches, are warm anodyne fomentations, light cataplasms, medicated with acetate of lead and laudanum, dilute tincture of iodine, and cantharidal collodion, the latter being applied in such a manner as to cover in the whole of the affected surface, and allowed to remain on until thorough vesication has been produced. If matter form, or even if there be merely great tension, the knife must be used, the incisions being long and deep, extending down to the very surface of the bone. Without such an expedient, relief is impossible. If the pus be allowed to accumulate, it will be sure to burrow, insinuating itself freely among the muscles, and, perhaps, even between the periosteum and bone, thereby detaching these parts from each other, and inducing extensive necrosis. What is done, in such a condition, for the soft structures, should, on the same principle, be done for the osseous. No surgeon hesitates when there is confined pus, along with great pain, tension, and swelling, to use the knife, making long and deep incisions to give vent to the effused fluid. Why should not a similar practice be adopted in suppurative osteitis? Here the matter is literally imprisoned, and can only be reached with the trephine. With a small instrument the bone is perforated at one or more points, followed by instantaneous relief, and the prevention of further inflammation, caries, and necrosis. This mode of treatment, in every respect so rational and effective, was originally brought before the notice of the profession in this country, in the latter part of the last century, by the late Professor Nathan Smith, of New Haven, and is one of the most valuable of the many practical suggestions made by that distinguished surgeon. An excellent paper, accompanied by the details of four cases illustrative of the beneficial effects of the operation, was published by his son, Dr. T. Morven Smith, in the American Journal of the Medical Sciences for 1838. In every one of these cases matter flowed freely from the bone, although only a few days had elapsed from the commencement of the attack.

In chronic osteitis the chief dependence is upon alterants, purgatives, and counter-irritation, of which the best form is an issue made with the hot iron as near as possible to the seat of the disease. A free discharge should be established and steadily maintained until the morbid action is effectually broken up. The most reliable internal remedy is iodide of potassium in union with mercury, carried, in obstinate cases, to gentle and somewhat persistent ptyalism. Such a course is particularly indicated in syphilitic osteitis, but is hardly less beneficial in the rheumatic, gouty, and strumous varieties of the malady.

Sir James Paget has described, under the term *osteitis deformans*, a remarkable variety of inflammation of the bones, characterized by enlargement and softening, with absorption of the old structure, and its replacement by fibrillar inflammatory tissue. The affection, which has also been observed by Wilks and Bryant, is usually symmetrical, and affects especially the skull and the long bones of the lower extremity, which become curved and misshapen under the superimposed weight of the body. It begins in middle age, advances slowly, does not appear to shorten life, and is attended with dull, aching pains. Three of the five recorded cases terminated in connection with carcinoma. The disease is progressive and irremediable.

SECT. VI.—SUPPURATION AND ABSCESS.

Suppuration of the external surface of bone is a very common occurrence, and may arise from various causes, as fracture and other external injury, or a syphilitic taint of the system. As the morbid action, however, which precedes and accompanies the suppuration, is usually associated with inflammation of the periosteum, it is difficult, in most cases, to determine which structure is really the source of the purulent matter. When the osteitis is of long standing, or characterized by inordinate severity, the pus is occasionally diffused through the proper substance of the bone, but such an occurrence can only happen in the event of the osseous tissue having undergone previous softening, the

removal of the earthy matter being followed by the formation of cells or cavities for the lodgment of the fluid. If a vertical section be made of a long bone, as the tibia, in an advanced state of inflammation, it will be found that the pus, presenting itself in small globules, will be scattered both through the Haversian canals and the cells of the areolar substance, no disposition being manifested in the little depots to arrange themselves into abscesses. The intermediate structure is of a reddish color, filled with fibrinous exudation, and so soft as to be easily divided with the knife. This punctiform variety of suppuration is seldom so conspicuous as in inflammation of bone complicated with endosteitis.

Abscess of bone, distinct, circumscribed, and well defined, such as is seen in phlegmonous suppuration of the soft parts, is a very uncommon affection, almost invariably a remote result of a syphilitic taint. The formation generally takes place slowly, an unusual degree of chronicity being one of its natural concomitants. The most frequent seat of the disease is the head of the tibia, as seen in fig. 369, or the head and lower extremity of that bone, the expanded and rarefied tissue of which is peculiarly well adapted to such an occurrence. The abscess ranges in size from that of a pea to that of a pigeon's egg; is generally solitary; is lined by a thin, although distinct, membrane; and is occupied by a dark-colored, ill-elaborated pus, more or less fetid, and intermingled with aplastic matter or curdy flakes similar to those observed in strumous pus. The surrounding tissues are softened, congested, and infiltrated with sero-sanguinolent fluid. The manner in which the abscess terminates is variable; when seated near the extremity of a bone, it sometimes discharges its contents into the contiguous joint; at other times, and more generally, it

Fig. 369.   Fig. 370.

Abscess in the Head of the Tibia.   Large Chronic Abscess, with a thickened, expanded Wall.

maintains its position, becoming, as it were, encysted by a deposit of new bone around it, as delineated in fig. 370. Finally, in a third class of cases, the matter continues to accumulate, apparently, for a long time, and, pressing upon the osseous tissue in every direction, gradually expands the bone into a large shell, capable of holding several ounces, and so thin and soft as to be bent and cut like cartilage.

The *symptoms* denotive of the formation of pus are usually such as characterize this event in the other tissues, only that the local suffering is generally much more intense, especially if the matter has no free vent. The existence of abscess in the interior of a bone is indicated by a dull, gnawing, heavy pain, circumscribed, deep-seated, remittent, and more like a violent toothache than anything else to which it can be compared. In many cases it is of a throbbing, boring, tearing, or lancinating nature. It is always worse at night than in the day, and is usually so intense and exhausting as to make serious inroads upon the general health, the patient soon becoming wan, sallow, and hectic. Occasionally the pain completely intermits, the parts being wholly free from suffering for many hours, and even days together; more generally, however, it is continued with partial remissions. The soft structures, at the seat of the abscess, are always exquisitely tender, especially at one particular spot directly over the matter, more or less tumefied, glazed, and œdematous, often pitting on pressure. The formation of matter is generally announced by rigors, alternating with flushes of heat; and similar attacks are very common during the progress of the disease, particularly in the early part of the night, the body being usually drenched towards morning with acid, offensive perspiration.

Although the symptoms of abscess are generally well marked, yet, as they may be simulated by other diseases, they cannot be said to be characteristic. The principal affections with which they are liable to be confounded are necrosis and deposits of new bony matter, compressing and irritating the parts so as to keep up intense pain and tenderness, similar to what is produced by collections of pus in the soft structures.

Fortunately, accuracy of diagnosis is of little consequence in these cases, as the treatment is essentially the same, whether the symptoms arise from abscess, the lodgment of dead bone, or interstitial osseous deposits. The discrimination between abscess and neuralgia, which often closely imitate each other, is of more importance, on account of the difference of treatment, but, so far as I know, there are no diagnostic signs by which the distinction can be effected.

The *treatment* of abscess of the osseous tissue is by efficient evacuation. In no other manner can the pent-up fluid be reached. The operation is not always so easy as might at first be imagined, owing to the excessive firmness of the affected bone, in consequence of interstitial deposits, which often give it the closeness and density of ivory. The best instrument is the burr of the surgical engine or a common trephine, fig. 371, from three to four lines in diameter, with sharp, well-set teeth, and fluted on the surface, so as to make a wide track. The surgeon, taking the site of pain and swelling, or the "tender spot," as his guide to the seat of the abscess, exposes the bone by a free incision, either single, T-like, curvilinear, or crucial, as may be deemed necessary, and then, turning aside a small portion of periosteum, applies the instrument. Its arrival at the abscess is generally denoted by a sudden cessation of resistance, and by the escape of a few drops of pus mingled with blood. If no matter is found after sinking the instrument to a considerable depth, it is applied at some other point, in the vicinity of the former, in the hope of a more successful result, for it is often quite impossible, in these cases, to hit the precise spot where the fluid is located in a first or even second attempt; on the other hand, however, care must be taken not to make too many perforations, lest the bone be thereby unduly weakened or suffer other injury. Moreover, it is not to be inferred by any means that although no pus has been detected, the operation will, therefore, be a failure; perhaps the instrument may have come in contact with a small sequester, lying loose in the connective tissue of the articular extremity of the bone, and by removing this rapid recovery make take place; or, instead of this, the pain and other symptoms may have been occasioned by the pressure of interstitial deposits, and the excision of a disk of bone may afford relief on the principle of taking off tension, as a free incision does in deep-seated, purulent collections in the soft structures.
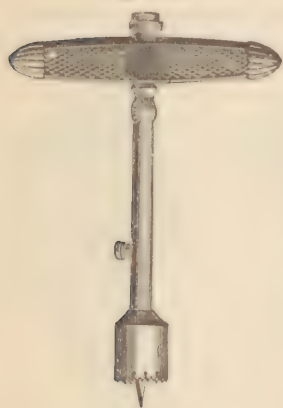
Fig. 371.

Trephine.

The abscess having been opened, the cavity is washed out with a syringe, as much to get rid of the sawdust as to clear away pus and stimulate the pyogenic sac. A narrow tent is then inserted into the bottom of the opening, and the wound gently supported with adhesive strips, the after-treatment being conducted upon strictly antiphlogistic principles. The relief from the operation is often immediate, and there is no class of cases in which the efforts of the surgeon are generally rewarded with more unalloyed satisfaction. The patient, tortured for months with pain and sleepless nights, is suddenly translated from torment into Elysium.

Trephining bone for the cure of circumscribed abscess was originally performed by Petit, in the earlier part of the last century; but to Sir Benjamin Brodie, who performed his first operation in 1828, is usually ascribed the credit of generalizing it. In this country the first case of the kind is said to have occurred in the practice of Dr. Walker, of Virginia, in 1757.

SECT. VII.—EROSION.

This condition of bone is altogether different from caries, although it is often confounded with it; nor does it, in any respect, resemble necrosis. It is simply a wasting of osseous tissue, induced by the force of steady and long-continued pressure. Practically, it is of little interest, except in so far that, as experience has abundantly proved, when the exciting cause of the erosion has been removed, the affected part, unless too greatly injured, is susceptible of repair to such an extent as to enable it to perform its accustomed function as a portion of the skeleton.

Three processes seem to be necessary to the production of this lesion, softening, absorption, and pressure; the latter acting as the exciting cause. Whether the softening is of an inflammatory character, or the result merely of the disintegration of the bone-corpuscles and the deposit of sero-oleagineous fluid, is still a disputed point, and one, indeed,

which, in the existing state of the science, cannot be determined. However this may be, a certain amount of softening is an indispensable preliminary to the morbid change, as, without it, the absorbents would be unable to perform their part of the work. The most common exciting cause is aneurism; but erosion of bone may also be produced by the pressure of an ordinary tumor, or even by an accumulation of pus, as is exemplified in chronic abscess of the spine, chest, head, and pelvis. When an aneurism is brought into contact with a bone, the surface of the sac contracts firm adhesions to it; then the compact layer of the bone, becoming softened by the pressure and pulsation of the tumor, gradually disappears, and thus the morbid action progresses until, at least in the worst cases, the piece is completely perforated, as is so often witnessed in the sternum, ribs, clavicle, and bodies of the dorsal vertebræ in aneurism of the thoracic aorta. In most of such cases the sac in immediate contact with the affected bone gives way, and thus allows its contents to bathe the osseous tissue.

The eroded bone has a rough, granular surface, with various depressions and elevations, owing to the irregularity of the absorption, and, in the dried state, looks very much as if it had been gnawed by the teeth of an animal. In case the pressure is relieved, as in an aneurism cured by the ligation of its feeding artery, the bone gradually assumes a hard, dense, ivory-like consistence, the surface ultimately becomes completely smooth and polished, and the areolar texture is, in great degree, if not wholly, annihilated. As to treatment, the only thing to be done is to remove the exciting cause, and, as this is seldom practicable, the surgeon is literally powerless.

SECT. VIII.—CARIES OR ULCERATION.

Caries is a disease of the osseous tissue, strictly analogous to ulceration of the soft parts. It is essentially of an inflammatory type, and is characterized by an increase of vascularity, softening, and disintegration, the earthy matter being separated from the animal, and eliminated along with the discharges, which are often quite profuse, especially when the malady has made considerable progress. Caries differs from ordinary osteitis chiefly in this, that it is attended with actual loss of substance, the affected tissue being gradually broken down, excavated, or destroyed, whereas in the latter it retains its various elements, although in an altered condition, the principal changes consisting in congestion, softening, and the formation of granulation tissue. There are other points of difference, as the seat of the two diseases, the age at which they respectively occur, and the nature of the concomitant secretions, as will be rendered evident by a careful study of the subject.

Caries is most liable to occur in parts of the skeleton distinguished by the abundance of their areolar tissue, as the vertebræ, the skull, the sternum, the innominate bones, the bones of the carpus and the tarsus, and the articular ends of the long bones, especially of the femur, tibia, and humerus. The compact tissue is more frequently the seat of necrosis than of caries; indeed, the affection cannot occur here unless this tissue has previously undergone a certain degree of softening, so as to prepare it, as it were, for the disintegrating process which characterizes it.

Young persons are most subject to caries, particularly children under ten years of age; it is seldom that it is met with even so late as middle life, and then chiefly as a result of some specific taint of the system, more especially the syphilitic. I am not aware that sex exerts any material influence upon its production. What are called strumous children are especially obnoxious to it, and this circumstance, of which daily observation furnishes abundant evidence, long ago created a doubt in my mind whether caries is not really, in a great majority of cases, of a syphilitic nature. The more I examine the subject, the more I am satisfied of the truth of this opinion. Most of the children that come under my observation with this disease, as it occurs in the spine, the hand, foot, and ends of the long bones, present all the characteristic features of the inherited form of that affection; and I am quite sure that this experience, instead of being peculiar to myself, must be common to all intelligent practitioners.

The exciting *causes* of caries are of two kinds, local and constitutional, of which the latter are by far the more common and influential. As appertaining to the first, are various injuries, as blows, kicks, falls, fractures, contusions, and concussions, disturbing the circulation and innervation of the osseous tissue, or depriving it of its fibrous covering, and thus modifying its nutritive action. In the bones of the foot, especially those of the tarsus, the disease is sometimes induced by the penetration of a foreign body, as a nail, or splinter of wood. The sawing of the bones in amputation and resection, and their accidental division by sharp instruments, are occasionally followed by caries, both extensive and protracted.

Among the internal causes of caries may be cited whatever has a tendency to induce general debility, or to impoverish the fluids and solids, and, consequently, to exhaust the constitution. Hence we may place at the head of the list severe and protracted courses of mercury, the operation of the syphilitic poison, scurvy, scrofula, profuse losses of blood, and severe attacks of dysentery, diarrhœa, typhoid fever, and eruptive diseases, as scarlatina, measles, and smallpox. All these circumstances are capable of producing ulceration both in the skeleton and the soft parts, as is proved by the numerous sores which so

Fig. 372.

Caries of the Head of the Humerus.

Fig. 373.

Caries, with Howship's Lacunæ.

often arise in different regions of the body, as the sequelæ of these affections, and which it is usually found so difficult to cure.

A carious bone exhibits marked differences in its appearances, according to the duration of the disease and the nature of the affected piece. In the earlier stages the osseous tissue is merely inflamed, as is evinced by its vascular and softened condition; its spongy texture is rarefied, and occupied by a serous, oily fluid, intermixed with a good deal of the coloring matter of the blood, thus giving it a reddish aspect. It may be cut with the knife, or even indented with the finger, especially if the bone is a carpal or tarsal one, and, upon macerating it, the water soon becomes covered with a layer of fatty matter. Exposed to the air, it dries with difficulty, and assumes a pale yellowish hue, verging slightly upon greenish. When the disease has reached its more confirmed stages, the bone is found to be excavated, or riddled with cavities, of variable size and shape, as in fig. 372, sometimes lined by a kind of pyogenic membrane, and filled with thin, sanious, and offensive matter, without any of the characteristic properties of laudable pus. These cavities are due to the absorption of the osseous lamellæ by the granulation tissue, which has formed at the expense of the cells of the medullary spaces and the Haversian canals, and the emigrant white corpuscles, and they correspond to Howship's lacunæ, seen in minute sections, as is represented in fig. 373, from Rindfleisch. Occasionally small fragments of bone, which have been deprived of their vascular supply, lie loose in these cavities, unable to escape on account of their disproportionate dimensions. The osseous tissue is now extremely soft and brittle, breaking down readily under the finger; it is still more porous than before, and is of a grayish, brownish, or blackish color. It is apparently destitute of vessels, and yields a considerable quantity of

Fig. 374.

Caries of the Astragalus, with Softening and incipient Separation of the Cartilage.

oil on maceration. In a chemical point of view, the only notable difference between carious and healthy bone is the greater amount of cartilage and fat in the former than in the latter, the quantity of cartilage often forming as much as thirty-seven per cent., while the amount of fat is upwards of three. This quantity of fat, although much greater than normal, is not sufficient to justify the opinion expressed by some that this disease essentially consists in adipose degeneration of the osseous tissue.

The substance immediately around the softened and disintegrated structure is always more or less inflamed, red, and vascular; the periosteum is thickened, spongy,

and injected; and the endosteum exhibits all the phenomena of active participation in the disease. The compact lamella has often a worm-eaten appearance, and it is not uncommon to find it partially incrusted with bony matter. The adjacent soft parts are infiltrated with sero-plastic matter, indurated, closely matted together, and otherwise altered. In articular caries there is always more or less involvement of the cartilages, which are gradually softened and disintegrated, large pieces often coming away with the discharges, as in fig. 374.

The *symptoms* of caries are usually obscure, especially in its earlier stages, as there is no line of demarcation between it and osteitis. It is only when the affection has terminated in suppuration, ulceration of the soft parts, as in fig. 375, or the formation of sinuses, that its true character can be fully made out. Prior to this the nature of the disorder may be suspected, but cannot be certainly determined. All the symptoms, in the first instance, are those simply of osteitis. There is a dull, heavy, aching pain, which

Fig. 375.

Caries of the Tibia, with an Ulcer in the Skin.

appears to be deeply seated in the substance of the bone, and which gradually increases in extent and severity with the progress of the morbid action; the part is exquisitely tender to the touch; the skin has a glazed, reddish aspect; and there is marked tumefaction, particularly at the focus of the inflammation. The local phenomena gradually augment in intensity, the pain assumes a throbbing disposition, the swelling becomes more pointed, and presently the loose, flabby integument gives way by ulcerative action, thus allowing the contents of the abscess, for such in fact the case is, to drain off. The bone thus laid bare has a foul, eroded appearance, at the same time that it is rough and so soft as to be easily penetrated with the probe.

The sinuses leading to the seat of the disease are either straight or tortuous, and vary in length from a few lines to several inches, according to the depth of the affected bone, and, above all, the place of opening of the abscess. In general they are multiple, and have separate orifices, so as to give the cutaneous surface a sieve-like appearance. In chronic cases the sinuses are lined by a species of false membrane, and their situation is indicated by a mass of reddish granulations, somewhat mammillated in shape, in the centre of which the aperture of communication is generally easily detected with the point of the probe. This nipple-shaped body, which is often entirely insensible, and almost always bathed with pus, projects considerably above the surrounding level, and is of great diagnostic value, as it is invariably denotive of the existence of carious or necrosed bone. The sinuses do not commonly all form at once; perhaps there may be only one or two at the beginning, the rest being superadded during the progress of the disease, or, perhaps, as one closes another appears. However this may be, the parts around are always more or less indurated, inflamed, and tender on pressure.

The discharge is commonly of a thin, ichorous, sanious, or bloody character, loaded with earthy matter, more or less fetid, and so irritating as to erode the parts with which it comes in contact. It usually tarnishes silver, a circumstance which shows that it contains sulphuretted hydrogen, and is often so profuse as to cause serious exhaustion. The earthy matter, which is easily detected by its gritty character, by rubbing the fluid between the thumb and finger, frequently amounts to two per cent. of the entire discharge. Sometimes the pus is of a laudable nature, but when this is the case it may generally be assumed that it is furnished by the adjacent soft parts rather than by the bone itself. It is not uncommon for it to contain flakes of lymph, the débris of connective and aponeurotic substance, and even considerable fragments of bone and cartilage, the latter being most apt to show themselves when the sinus penetrates a neighboring joint.

There is a form of caries, which, as there is an entire absence of suppuration, may be called *dry caries:* it is most commonly met with in syphilitic disease of the cranium, and

I have also witnessed it in ulceration of the articular extremities of the long bones, especially of the head of the humerus, and of the femur. Associated with this condition of the osseous tissue, there is usually marked rarefaction of the cancellated structure with inflammatory thickening of the surrounding soft parts.

The constitutional disturbance is not always proportionate, so far as can be judged, to the amount of the local disorganization. The general health is often but little affected, especially in the early stages of the disease; by degrees, however, it begins to give way, and ultimately suffers severely. The patient loses flesh and strength, the countenance is wan and pallid, and the sleep and appetite are destroyed. If the disease is at all extensive, or if, even when it occupies but a small compass, it opens into a large joint, as, for example, the knee, hectic irritation soon sets in, and, making rapid inroads upon the system, speedily reduces the vital powers. The pain is often excruciating, particularly at night and in damp states of the atmosphere, and is one of the principal sources of exhaustion.

The *diagnosis* of caries can, in general, be determined only by a careful consideration of the history of each individual case. Until ulceration of the soft parts occurs, the nature of the disease must almost necessarily remain an enigma. The only affection with which it is liable to be confounded is necrosis, but from this it may usually be easily distinguished, before the skin has given way, by the comparatively small amount of the attendant pain, as well as by the lesser degree of constitutional disturbance, and by the fact that caries is usually met with in the short bones, while necrosis mostly occurs in the shafts of the long. When sinuses have formed, the eye, finger, and probe are usually able to determine the diagnosis, by the appearance and feel of the affected structure. In both cases the bone is roughened, but usually much more so in necrosis than in caries; in the former it always retains its original consistence, whereas in caries it is so much softened as to be readily penetrated by the probe. Nothing of a definite character can be learned from the nature of the discharge, since it is nearly identical in the two maladies. Occasionally valuable information may be obtained from a consideration of the exciting cause. Thus, osteitis from syphilis terminates more frequently in necrosis than in caries, the reverse being the case in inflammation dependent upon a scorbutic or strumous taint of the system. To this statement, however, numerous exceptions occur, and the diagnosis must, therefore, at least in most cases, be a matter of time and of repeated critical examinations.

The *prognosis* of caries is generally unfavorable, a spontaneous cure, although not impossible, being an extremely uncommon occurrence. When the disease is of limited extent, a cure may often be promptly effected by operative measures directed against the affected parts, but under opposite circumstances nothing short of resection or amputation holds out the slightest prospect of relief. In many cases the affection continues for years, apparently neither advancing nor materially receding, the general health in the mean time experiencing but little change; on the other hand, however, its progress is sometimes very rapid, and the constitutional disturbance proportionately great, hectic irritation, loss of strength, and emaciation setting in early, and steadily proceeding until the patient dies completely exhausted. Caries is less likely to terminate favorably when it assails the vertebræ and the articular ends of the long bones than when it appears in any other portions of the skeleton, except, perhaps, the carpal and tarsal bones, in which it is often so extremely obstinate as to require the removal of the limb in order to save life. The prognosis is, of course, more unfavorable in sickly and debilitated persons than in such as are healthy and robust at the time of the attack.

Treatment.—The treatment of caries should always, if possible, be conducted with strict reference to the nature of its exciting causes. When the disease has been induced by a syphilitic, strumous, or scorbutic taint of the system, remedies adapted to these respective contingencies will, of course, promptly suggest themselves, as most likely to fulfil the particular indication of the case; but where no such affection is visible, and where, in fact, nothing whatever of an appreciable character exists, the surgeon must disregard all rules, and limit himself to the application of general principles. The diet should be very plain and simple, but at the same time nutritious, so as to build up the system, and create a better state of the blood, which is generally so much at fault in caries of nearly all portions of the skeleton. Chalybeate tonics, quinine, nux vomica, and cod-liver oil are the most valuable internal remedies; aided, as occasion may seem to demand, by blue mass and alkalies, to modify and improve the secretions. Active purging is avoided, as it would inevitably prove prejudicial by its debilitating effects. Exercise in the open air is often of great service, but, to render it efficient, the diseased bone must

not be moved or irritated during its performance. Salt-bathing, followed by dry friction, will be beneficial in imparting tone and vigor to the cutaneous capillaries; and in many cases the general health is much improved by a residence at the seaside.

Irritation of the soft parts is allayed by attention to rest and position, and by the application of leeches, fomentations, and poultices, or warm water-dressings medicated with laudanum and acetate of lead. When there is much induration from deposits, the skin should be freely painted twice a day with dilute tincture of iodine, followed, if the case prove obstinate, by a large blister, experience having shown that, in superficial caries, this is more effectual in arresting inflammation than any other remedy. Even in deep-seated caries it frequently answers an excellent purpose, promptly allaying the excessive pain, and promoting the absorption of effused fluids. As soon as evident fluctuation exists, or even before, if there be inordinate tension and throbbing, a free incision should be made, extending, if possible, into the very depths of the bone, so as to admit of the most thorough drainage. To allow the matter to remain pent up always proves excessively injurious, from its tendency to burrow among the surrounding structures, detaching them from each other, and leading, in the end, to the formation of numerous sinuses. Besides, the early evacuation of the matter greatly abridges the suffering, constitutional as well as local, and thus prepares the system better for the future struggle. When the matter is lodged in the interior of a bone, as, for instance, the extremity of the femur or tibia, evacuation should be effected with the trephine.

The means now described are all merely of a palliative nature; they relieve pain, swelling, and constitutional disturbance, but cannot cure the disease, however slight. To fulfil this indication, other remedies are necessary; some for modifying the affected tissues, so as to afford them an opportunity of regaining their normal characters, and others for effecting riddance of the diseased bone either in part or in whole.

Under the first head may be mentioned various detergent and acidulated preparations, as solutions of the chlorides, creasote, nitrate of silver, and acetic, nitric, and hydrochloric acid, their strength varying with the age and constitution of the patient, and the state of the parts, the contact being effected by means of a large glass syringe, repeated twice in the twenty-four hours. The chlorides are particularly serviceable in these cases, on account of their cleansing and deodorizing effects, while the acids act more directly upon the osseous tissue, stimulating the capillary and absorbent vessels, and thereby promoting a more healthy tone, at the same time that they produce disintegration of the earthy matter of the diseased bone. These remedies, and all others of a kindred nature, are certainly not without some benefit in the milder and more accessible cases of caries, but they all have the disadvantage of being difficult of application, as well as uncertain in their results, and can rarely be relied upon for a cure. I have, therefore, of late years, entirely abandoned their use with this intention, and now employ them only with a view to their detergent and deodorizing effects, preferring, of course, the chlorides to any of the other articles for this purpose.

The actual cautery, formerly so much vaunted in the treatment of certain forms of caries, especially in that of the carpal and tarsal bones, is obnoxious to the same objections as the remedies just mentioned. In applying it, it is necessary not only to divest the affected bone thoroughly of its soft parts, but to employ the greatest circumspection, otherwise a much larger amount of tissue may be destroyed than is desirable. Moreover, the eschar is always a long time in coming away, and the iron has generally to be used again and again before a cure is finally effected.

In the treatment of caries of the deeply-seated bones, Dr. Fitzpatrick enlarges the sinuses with the Vienna paste, and after having pierced the exposed bone with a strong knife, inserts the caustic into its interior. I have had no experience with this practice; but regard it as even more objectionable than the application of the actual cautery.

Under the second head are included the operations necessary for scraping or cutting away the diseased structure, excising the affected bone, either in part or in whole, and amputating the affected limb, when the case is unmanageable by other means.

All operative interference, having for its object the removal of the carious matter, is, as a rule, carefully abstained from until the disease has become strictly chronic, or, in some degree, ceased to spread. If this injunction be disregarded, injury and not benefit will be certain to follow, the irritation excited by them giving new impetus to the morbid action. The precise time for interference cannot, of course, be specified, but it is evident that no attempt should be made to scrape or cut the bone so long as the superimposed parts are very tender, tumid, and inflamed. The proper treatment, in this condition,

consists in the use of leeches, medicated fomentations, and other antiphlogistic measures designed to soothe the irritated structures, and prevent the spread of the disease.

When the caries is of small extent, it may generally be removed by means of a burr-head drill, similar to that used by the dentist for scraping away caries from decayed teeth previously to plugging. With such an instrument, of which the adjoining sketch, fig. 376, affords a good idea, the whole of the diseased substance may be cut away in a few minutes,

Fig. 376.　　　Fig. 377.　　　Fig. 378.　　　Fig. 379.　　　Fig. 380.
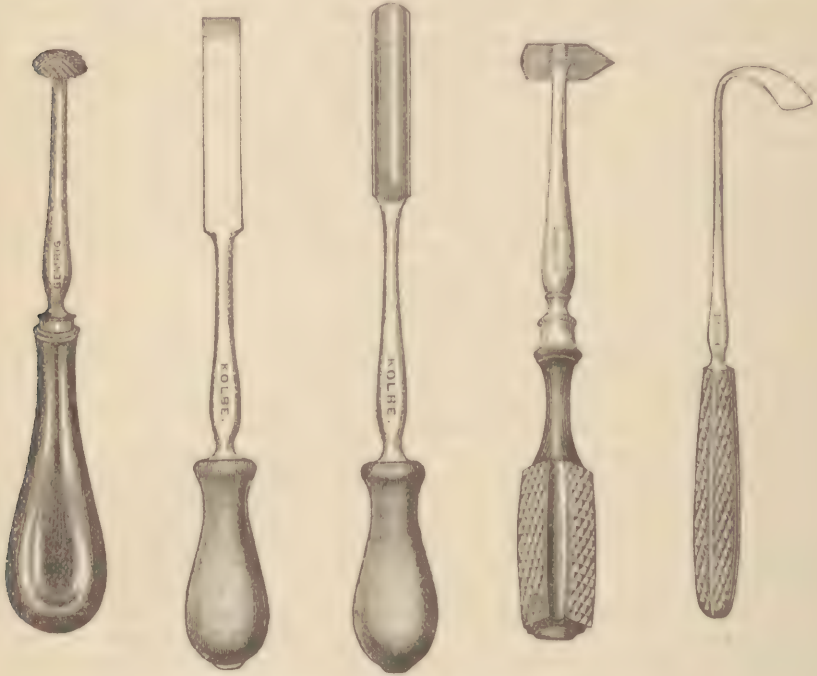
Instruments for removing Carious Bone.

with little pain to the patient, and no detriment whatever to the neighboring parts, which should always be turned aside immediately prior to the operation. Every bone-case should have from three to six drills, of varying size and shape, so as to meet every contingency that may arise in practice. Several trephines, pliers, gouges, chisels, and scrapers should also be at hand. In operating upon the tarsal and carpal bones, a short, stout scalpel, with a rather sharp convex extremity, and a large handle, will generally be found to be very desirable. Such an instrument is peculiarly advantageous in paring the surface of deep-seated cavities. When the ligaments and cartilages are involved, dissection can hardly be completed in a satisfactory manner without a pair of blunt-pointed scissors, with long, thick, narrow blades. The raspatory is useful in smoothing carious cavities after the removal of the disorganized substance. During the operation the diseased cavity is kept free from blood by means of the elastic bandage and of sponge mops.

When all the diseased structure has been removed, the affected cavity should be thoroughly washed out with a syringe. Unless this be done, more or less of the bony matter will be left, thus keeping up irritation and discharge, and interfering with the reparative process.

Considerable hemorrhage often attends these operations, the blood either proceeding from small arteries, or oozing from numerous points. In the former case the ligature will usually be required, more particularly as the vessels are unable to retract on account of the indurated condition of the surrounding parts, while in the latter the temporary application of the sponge wrung out of hot water will commonly speedily arrest the flow. If this do not answer the purpose, the bleeding cavity must be stuffed with lint soaked in a strong solution of subsulphate of iron, the plug being retained until it is loosened by the suppurative process.

Doubt is often experienced, in these operations, as to the amount of substance to be removed, the precise line of demarcation between the sound and diseased structures

not being always easy of determination. A good diagnostic, under such circumstances, is to wash the fragments in water, when, if they are carious, they will exhibit a whitish, grayish, greenish, or blackish appearance; whereas, if they are healthy, they will be found to be vascular and red, and to retain their normal consistence, presenting none of the fragile and porous characters which distinguish them in the former case.

Bleeding having been arrested, the edges of the wound are loosely approximated by suture; and the limb, placed in a favorable position for drainage, is inclosed in a bandage, the affected parts being covered with lead water dressing. Occasionally a tent is needed to conduct off the matter, and prevent premature closure; and for some time the bony cavity should be injected twice or thrice daily with tepid water and castile soap, or some gently detergent lotion. The great sources of danger after the operation are erysipelas and pyemia.

Fig. 381.

Structure of a Granulation in a Bone.

The healing process, after such an operation, is attended by the development of granulations, which, under the microscope, display very much the same appearances as those of the soft parts. The vessels, as shown in fig. 381, from a drawing made for me by Dr. Packard, have a remarkably looped and varicose arrangement. The specimen was taken from an ulcerated patella, which was covered by an immense number of beautiful scarlet granulations, hardly the size of the smallest pin's head, closely grouped, and exceedingly tolerant of rude manipulation. The section was magnified sixty diameters.

Excision of an entire bone is sometimes necessary for the relief of this disease. Such a procedure is most frequently required on account of caries of the carpal and tarsal bones, upon which it is frequently performed with great advantage, a useful limb being generally left even after the removal of several of these pieces. In the long bones, the operation is usually limited to the articular end, or to this and to a portion of the shaft. Respecting the manner of executing this operation, and the estimate to be placed upon it, in a curative point of view, special mention is made in the chapter on excision.

When the disease is so extensive as to be uncontrollable by the means now described, and the attendant discharges are so copious as to give rise to profuse night-sweats, marasmus, and colliquative diarrhœa, amputation of the limb, comprising the carious bone, affords the only chance of safety, and should be performed without delay. It is surprising how the system usually rallies after such an operation. The patient, in the course of a few days, generally looks like a new being; his sweats and diarrhœa soon leave him, and he rapidly improves in health and spirits, making often an excellent recovery.

SECT. IX.—NECROSIS OR MORTIFICATION.

The word necrosis denotes the death of a bone, and is strictly synonymous with mortification, gangrene, or sphacelus, used to designate the death of a soft structure. The immediate cause of the occurrence is inflammation, eventuating in an arrest of the circulation and innervation of the osseous tissue.

Necrosis is most common in the superficial bones, or in those which lie immediately beneath the integument, as the tibia, ulna, lower jaw, clavicle, femur, and the phalanges of the fingers. The long bones suffer more frequently than the short, and the short than the flat, the reverse being the case in caries, for the reason that, in the former, the compact tissue is most commonly affected, and in the latter, the spongy.

Children under fifteen years of age, of a strumous diathesis, or a syphilitic taint, are the most common subjects of this disease. Of the influence of sex, climate, and occupation, upon its production, nothing satisfactory is known. It has generally been supposed, and not without reason, that it is most common in cold, damp, and variable regions, on the assumption that the inhabitants of these countries are particularly subject to suppression of the cutaneous perspiration, which, in individuals predisposed to disease, may, it is alleged, readily cause death of the more superficial bones. Persons engaged in the manufacture of lucifer matches are liable to necrosis of the jaw, from

the contact of the fumes of phosphorus with the interior of decayed teeth; and it is not improbable that there are other pursuits which may conduce to destructive inflammation of the osseous tissue, although of their precise nature and mode of action we are not informed.

Causes.—The idiopathic form of necrosis will be found, as a rule, to be most common in young subjects whose constitution has been hereditarily damaged, or who exhibit well-marked evidence of the scrofulous diathesis, as evinced by the delicacy of the skin, the languid circulation, the tumid belly, and the deficient temperature of the extremities. This has certainly been the case in the great majority of instances that have come under my own observation, and I believe that my experience, in this respect, in the main, agrees with that of other writers. It is in persons of this description, more particularly, that we so frequently meet with the worst species of necrosis of the tibia, femur, and humerus, telling so fearfully upon the constitution, and so often requiring amputation in order to save the patient's life. The most common exciting cause of the disease, in this class of subjects, is exposure to cold, as when a boy, overheated by play, sits down in a current of air, and thus suddenly repels his perspiration; or when, under similar circumstances, he strips himself and plunges into cold water. Not aware, perhaps, for several days that he has sustained any injury he is suddenly seized, not unfrequently while asleep, with violent pain in one of his limbs, attended with severe rigors alternating with flushes of heat, and, upon examining the affected part, he observes that it is exquisitely tender on pressure, more or less swollen, and covered with an erysipelatous blush. The local and constitutional symptoms progressing, matter soon forms deeply beneath the muscles, the swelling becomes more and more circumscribed, and, ulceration taking place, the contents of the abscess gradually find their way to the surface, leaving the bone dead below. Such is the manner in which necrosis is generally produced in weakly, scrofulous subjects, and it is hardly necessary to add that all the attendant phenomena are indicative of a rapidly destructive osteitis, osteomyelitis, or osteitis and periostitis.

Tertiary syphilis is another cause of necrosis, and the history of this disease shows that the osteitis growing out of it is more liable to occasion death of the bone when the patient has been subjected to free courses of mercury for its cure, than when the affection has been treated on general antiphlogistic principles. The two poisons coming together, and mingling their baneful influence, induce a form of inflammation which is extremely prone, especially in persons of a worn-out, debilitated constitution, to terminate in gangrene of the bones, particularly those of the nose, palate, upper jaw, leg, and arm.

Protracted courses of mercury, especially in young subjects of a strumous diathesis, or exhausted by diarrhœa, cholera, or eruptive diseases, often cause necrosis of a frightful character, generally of the maxillary bones, but sometimes, also, of other pieces of the skeleton. What is termed dry salivation is frequently more destructive to the gums, teeth, and jaw-bones than salivation accompanied by profuse discharge. The debility provoked by the injudicious use of drastic purgatives and tartar emetic has occasionally eventuated in necrosis of some of the bones of the head, trunk, and extremities. Scurvy has been known to produce similar effects, although more commonly it causes caries. In short, there is reason to believe that idiopathic necrosis may be induced by whatever has a tendency to bring about an impoverished condition of the blood and solids.

Among the local causes of necrosis the most common are wounds, contusions, fractures, amputations, and chemical irritants. In the tibia and femur, the probability is that mere concussion, as happens when a person falls from a considerable height and alights upon his foot or knee, is often sufficient to produce a destructive form of osteitis. Gunshot injuries are a frequent source of the occurrence, whether the bone is merely grazed by the passage of the projectile, or whether the ball lodges in its substance and acts as a foreign body. Partially detached splinters frequently perish under such circumstances. Mere denudation of a bone, however occasioned, is often followed by its death, especially when the loss of periosteum is very considerable, or if, even when it is comparatively trivial, it is accompanied by the laceration of the nutrient artery, or extensive destructive of the soft parts generally. In this condition, the necrosis is usually limited to the outer compact structure, the part ultimately coming away in the form of an exfoliation. Such an event, however, is by no means inevitable. The periosteum may be stripped off to a considerable extent, and yet, if the bone is in other respects healthy, or enjoys a tolerably active circulation, granulations will spring up, and thus gradually repair the breach. It is only when the vascular connection between the two structures has been materially impaired, or totally destroyed, that necrosis will be likely to ensue, the bone becoming white and

dry, and ultimately dark and even black. These appearances are well illustrated in what so often happens in compound fractures, attended with protrusion of the end of the bone divested of its fibrous covering, and in the phalanges of the fingers in whitlow.

Death of bone is occasionally produced without the intervention of inflammation, from mere shock, contusion, or compression of the component elements of the osseous tissue, and the sudden arrest of the circulation from obstruction of its vessels, however induced. Embolism probably plays an important part in the causation of such cases, just as it sometimes does in mortification of the soft parts, and, occasionally, again the trouble may be due to the rupture of the nutrient artery.

Necrosis may be partial or complete, simple or complicated, superficial or deep ; that is, it may be limited to a portion of a bone, or it may pervade its entire thickness. It is seldom that an entire bone perishes. Such an occurrence is sometimes observed in the carpus and tarsus, in consequence of external injury, but it is extremely uncommon in the long bones ; in these the shaft alone generally suffers, the articular ends retaining their vitality. Necrosis of the whole lower jaw has been repeatedly noticed as a result of the action of phosphorus, and some interesting cases in which the entire bone was successfully removed on account of this disease have been related by Dr. Carnochan, Dr. J. R. Wood, and others. Finally, necrosis may be limited to the outer surface of a bone, involving merely its superficial lamellæ, the dead portion being ultimately detached in the form of a thin scale or plate ; or it may invade its entire thickness, and it then not unfrequently begins in the very depths of the cancellated tissue, generally from injury or disease of the medullary membrane.

The occurrence of necrosis, the elimination of the dead bone, usually called the sequester, and the formation of new bone as a substitute for the old, or that which has died, involve some very curious pathological and physiological processes, deserving of attentive consideration. The symptoms which immediately precede, and those which accompany the death of the bone, are generally such as are denotive of violent inflammation, deep-seated, attended with excruciating pain, and rapidly tending to the suppurative crisis, the mischief being often done in a few days, or even in a few hours. Action, general as well as local, is excessive, and both the part and system occasionally fall a prey to its devastating influence, especially when there is involvement of a large neighboring joint, as now and then occurs when the necrosis attacks the inferior extremity of the femur, and extends into the knee. Progress, however, is not always so swift and overwhelming ; often it is quite the reverse, the parts and system suffering but little, and the malady pursuing apparently a chronic course.

A very common way in which the occurrence of gangrene of a long bone is announced is this. The patient, usually a lad from six to ten years of age, after having been over-heated or exposed to severe cold, retires at night apparently perfectly well, but towards morning he is aroused by pain in the thigh or leg, deep-seated, circumscribed, of a sharp, aching character, and so excessively severe as to deprive him of further sleep and rest. The soft parts over the seat of the disease soon become exquisitely tender to the touch, swollen, and discolored, the surface having a glazed, dusky, reddish, or purplish tint, and pitting under pressure from the infiltration of the subcutaneous connective tissue. These local phenomena are always attended by severe constitutional disturbance. There is high, raging fever, with a tendency to delirium, and excessive restlessness ; the pulse is full, hard, and frequent ; the skin is hot and dry ; the thirst is incessant ; and the urine, thick and scanty, is surcharged with lithic acid. By and by, violent rigors set in, succeeded by flushes of heat, the pain assumes a tensive, throbbing character, the swelling becomes more diffused, extending often to a great distance up and down the limb, as well as widely circumferentially, the discoloration acquires an erysipelatous blush, and a careful examination soon detects, what, indeed, the existing symptoms sufficiently declare, the presence of pus, deep-seated, lying partly between the affected bone and the periosteum, and partly on the outside of the membrane, in the connective tissue of the muscles and aponeuroses, which it often extensively dissects and separates from each other, forming large pouches from which it is frequently difficult to dislodge it. Sometimes the abscess opens into a neighboring joint, and thus becomes a source of additional mischief, exciting inflammation in the synovial membrane, perhaps ultimately followed by destructive softening of the cartilage, and caries or necrosis of the end of the bone.

The quantity of matter at this stage of the disease varies from a few ounces to upwards of a pint, and is mostly derived, not from the affected bone, or bone and periosteum, but from the soft parts in their immediate vicinity, which always freely participate in the morbid action. In spontaneous necrosis, it is usually of a strumous character, of a yel-

lowish color, verging upon greenish, more or less fetid, especially if long retained, and of a thick, cream-like consistence, interspersed with curdy substance, and, not unfrequently, also with shreds of dead connective tissue. Occasionally the matter is thin, ichorous, or sanious, but such an occurrence is unusual until after the bursting and the evacuation of the abscess.

When the matter has been discharged, whether spontaneously or artificially, there is always a marked improvement in the symptoms, both local and constitutional, and an opportunity is now afforded for a thorough examination of the parts. The best instrument for this purpose is the finger, or, when the opening is very small or devious, the probe. With either of these it is generally easy to determine the extent of the destruction of the periosteum, and the amount of injury sustained by the bone, the surface of which will generally be found to be more or less rough, and of a whitish, grayish, or ashy hue, without any appearance whatever of vascularity.

Such is a succinct account of the circumstances which precede, accompany, and follow the ordinary occurrence of necrosis. The first stage of the disease is over: the matter consequent upon the inflammation has been discharged; and the inflammation itself has measurably subsided, although the soft parts are still swollen, indurated, tender, painful, and disabled. Nature, never idle, now begins the double work of elimination and repair, both usually very tardy, often imperfect, and sometimes altogether unsatisfactory, the powers both of the part and system being inadequate to accomplish the object. In gangrene of the soft structures, the separation of the eschar is generally an easy matter compared with that of a bone, provided the patient's strength holds out; the process, once fairly commenced, proceeds rapidly and energetically, the surgeon each day seeing decisive evidence of the fact; soon the line of demarcation between the dead and living parts is perceived; then granulations spring up in the intervening chasm; and, finally, the reparative efforts still advancing, the breach is gradually closed over with new skin, a circumstance clearly denotive of the completion of the cure. But it is altogether different in necrosis; here the detachment of the slough is a matter of time, requiring many weeks, if not several months, for its satisfactory conclusion, and even then generally demanding the interference of art before it can finally be effected. The cause of the difference is sufficiently obvious. In the one case there is an active circulation and an energetic system of absorbents, the former furnishing an abundance of plastic material for the repair of the lost tissues, and the latter exerting themselves to cast off the dead substance; in the other, on the contrary, everything is the reverse, and the parts labor under the additional disadvantage of being loaded with earthy matter, which is obliged to be softened and disintegrated before it can be removed by the vessels whose duty it is to get rid of it.

Fig. 382.

Sequester of the Tibia.

The necrosed substance may, as already stated, embrace merely a portion of the periphery of a bone, as, for example, its outer layer; or it may include its entire thickness, and also the greater part of its length. In the former case it constitutes, when detached, what is called an *exfoliation*, in the latter a *sequester*, a distinction of considerable importance, not so much on account of the extent of the dead substance, as of the manner in which the breach of continuity is repaired, or a new bone formed.

An exfoliation is commonly merely a thin scale, plate, or lamella of the outer, peripheral portion of a long bone, of variable color, and consistence. In general it is either whitish, grayish, or of a light brownish hue, rough, more or less porous, very brittle, and in great measure deprived of animal matter.

A sequester, properly so called, varies much in size and shape, consisting, at one time, of a part only of the circumference or length of a bone, and, at another, of its entire shaft, with perhaps a portion of its articular ends. The adjoining sketch, fig. 382, from a preparation in my collection, represents a very common form; it was a part of the body of the tibia, in which all the spongy structure is completely destroyed, while the compact is remarkably hard and firm. A dead bone, as a rule, is rough, pitted, or excavated, seldom perfectly smooth, spiculated at the extremities, of a grayish, brownish, or blackish color, and emitting when struck with a probe or piece of metal, a peculiar hollow sound, by which it is usually readily distinguished from healthy bone. In the cylindrical pieces, as in the femur and tibia, it is generally dense and dry; in the short and flat, porous, moist, brittle, and easily crumbled. The analyses of Von Bibra show that there is a very

great reduction of organic matter in necrosis, with a corresponding increase of earthy, the latter forming as much as eighty per cent. of the entire mass. The same experimenter has ascertained that the difference is considerably less in the acute variety of the lesion than in the chronic.

Bone recently dead, or bone in a dying condition, before the establishment of the eliminating process, is generally of a dirty grayish, greenish, or brownish color, more or less moist, and excessively fetid, the odor resembling the stench of a macerating tub. In rare cases it is of a purple, lilac, or blackish hue, especially when the devitalization has been preceded by deep congestion, or congestion and ecchymosis, of the osseous structure. When a bone perishes very suddenly, the affected part is comparatively dry, and free from smell.

Necrosis of the articular extremity of a bone does not differ essentially from that of its shaft. It may be superficial, as when it affects the articular surface alone; deep-seated, as when it occurs in the cancellated structure; or universal, as when it invades the entire thickness of the extremity. However this may be, it is always accompanied by inflammation of the synovial membrane, or of this membrane and of the articular cartilage, and is very liable to be followed by permanent ankylosis. The joint is swollen and indurated, excessively painful, pierced by sinuses, and the seat of more or less profuse discharge of unhealthy matter. The affected bone itself is generally remarkably soft, saturated with sanious fluid, and of brownish, grayish, or slightly greenish color. The disease is most frequent in young, scrofulous children, and after gunshot, railway, and other severe injuries.

When necrosis occurs in the spongy structure of an articular extremity, the sequester may be so firmly incarcerated in the interior of the bone as to render it difficult of access. Sometimes the entire extremity perishes, as is exemplified in the head of the thigh-bone in coxalgia, in the condyles of the femur after gunshot and other injury, and in strumous or syphilitic disease of the head of the humerus. In a case of necrosis of the latter bone, in a lad ten years of age, recently under my care at the College Hospital, the head of the bone had entirely disappeared; and a similar fate is occasionally experienced by the corresponding portion of the femur.

In what is known as *dry necrosis*, a rare affection, there is an entire absence of suppuration, the bone being free from moisture, and of a brownish or dark grayish color. The disease, originally described by Stanley, in 1849, has since been noticed by Baker, Sir James Paget, and other observers, chiefly in the long bones, and is, in every respect, analogous to senile gangrene of the soft structures, the osseous tissue gradually dying in consequence of disordered circulation interfering with a due supply of blood, and followed by chronic inflammation. The sequester, in such cases, is usually slow in separating, and so firmly imprisoned by the new bone as to render it extremely difficult to remove it. In some cases a portion of endosteum retains its integrity, and thus two involucres are formed, one by this membrane, and the other by the periosteum; but such an occurrence is uncommon.

Mode of Repair.—While the adjacent living bone is engaged in detaching the dead bone, with a view to its ultimate expulsion, the latter acts as a foreign body, and sets up mild inflammatory changes in the periosteum, the soft layer of which proliferates, becomes embryonic, and furnishes the material for the formation of the substitute or new bone, the process by which this is accomplished being similar to that which presides over the creation of the original structure, the period required for the completion of the development varying, according to the age and vigor of the patient, and the character and amount of the local disease, from a few weeks to several months. The new bone is at first a mere shell encasing the old, and thus serving to separate it from the surrounding parts, which ill brook its presence. In time, however, it increases in thickness, being often from three to six lines in depth, and occasionally it is fully as large as the original piece. Its surface is usually somewhat rough, and it is not uncommon to observe upon it considerable eminences

Fig. 383.   Fig. 384.

Necrosed Tibia, the dead Bone lying loose within the New.

Cloaca in a necrosed Tibia.

and depressions, owing evidently to the irregularity of the developmental process. The new substance, too, has comparatively little areolar tissue, and, therefore, especially if some time has elapsed since its formation, it is always cut with great difficulty, the resistance offered by it being much greater than that of the preëxisting structure. In cases of long standing, indeed, it often acquires the solidity and density of ivory, so that it requires great patience and perseverance to penetrate it with the saw and pliers. The vessels, in this event, are always very small and sparse, and the Haversian canals are traced with difficulty. In the long pieces, after the death and removal of the shaft, there is never a complete reproduction of the medullary canal and its lining membrane, or of the endosteum. In fact, the new bone, although it possesses all the essential attributes of the osseous tissue, is, nevertheless, a very imperfect type of the original, and, therefore, much less capable of resisting the effects of disease and accident. The appearances of the new bone, encasing the old or dead, are admirably depicted, in fig. 383, taken from a specimen in the collection of the late Professor Pancoast.

In viewing the new bone as it surrounds the old, its surface is found to be pierced by several apertures, to which, from their fancied resemblance to the rectal pouch of a bird, the term *cloacæ*, fig. 384, is usually applied. These openings, which play an important part in the expulsion of the dead bone, owe their existence to a deficiency of periosteum, or of secreting structure, as is proved by the fact that, when the formation of new osseous tissue goes on uniformly around every portion of the periphery, the old bone will be completely imprisoned, thus not only obscuring the diagnosis, but rendering the removal of the sequester a matter of great difficulty and perplexity. The size of these cloacæ varies, in different cases, from that of a three-cent piece to that of a quarter of a dollar, their shape being generally rounded, or somewhat oval. Not unfrequently, however, they occur in the form of long, irregular fissures, or slits. Their number is indefinite; sometimes there is but one, while at other times there may be as many as half a dozen, the latter number being by no means uncommon in necrosis of the shaft of the tibia. However this may be, they always communicate with the surface of the limb in which the affected bone is situated, the passages between them constituting so many channels for the discharge of matter and the ultimate elimination of the sequester, although, owing to the inadequate dimensions of the cloacæ, this is seldom effected without the intervention of art. It is an interesting fact, of no little practical value, that these openings are always situated in that portion of the new bone which is least covered by soft parts. After the removal of the sequester they generally disappear under the development of new osseous matter.

There has been much dispute among pathologists as to the agents by which the new bone is produced. Without entering into any details, I may state, as the result of personal observation, that the perfection of the new bone will generally be in proportion to the integrity and activity of the periosteum. I have always found that, when this membrane has suffered much during the inflammation which precedes and accompanies the necrosis, the reproductive process, or new osseous epigenesis, is tedious and difficult, and often extremely inadequate, the new bone being comparatively small and stunted, and, therefore, ill adapted to answer the purpose of a substitute bone. The part which the periosteum plays in the development of the new bone is well shown in the formation of cloacæ, which, as already stated, is clearly dependent upon the partial destruction of that membrane. If the periosteum everywhere retained its integrity, the new bone would be without a solitary opening, and, consequently, the sequester, or slough, would be an encysted body, imprisoned, as it were, in a closed canal. When this membrane has perished along with the bone, as occasionally happens in the shaft of the tibia or femur, the new bone will be formed by the surrounding structures, whatever these may be, but it will be so short, thin, and imperfect as hardly to deserve the name of substitute, to which, in general, it is so well entitled.

When the eschar presents itself as an exfoliation, or as a thin, superficial scale, the breach is repaired through the medium of granulations, which, being derived from the old bone, are extremely vascular and sensitive, and soon assume the ossific process, throwing out an abundance of proper material for the accomplishment of the object. A similar process is set up when the central portion of a bone perishes; for here, the endosteum being also destroyed, it can have no agency in the reproductive act. When this membrane retains its vitality, it must necessarily exert an important influence as an osteogenic agent.

The idea has been broached, and warmly defended, that when the shaft of a bone is necrosed, so as to leave merely its articular ends, the new bone is formed exclusively by these ends, the osseous matter extending gradually towards the middle of the chasm, and

ultimately coalescing there. Such a theory, however, is wholly untenable, as it is contrary to what occurs in the growth of the original bone, which always takes place by several distinct points, one of which is invariably central. However well the surviving extremities might perform their duty, yet, as there is no central nucleus, serving as a point of departure for the ossific matter, it is easy to conceive that the bone would always necessarily be so deficient at that particular spot as to disqualify it materially for the performance of any useful functions.

Although the osteogenic properties of the periosteum, have long been familiar to the surgeon, through the labors of Troja, Koehler, Weidmann, and other observers, new light has been thrown upon the subject by the admirable and exhaustive experiments of Dr. Ollier, of Lyons, since confirmed by other observers. He found that, in rabbits, portions of this membrane, completely detached from the bone, might be pushed into the soft structures, and still preserve their power of generating osseous matter. In some cases, indeed, this faculty was not lost when the periosteum was transplanted to remote parts of the body, or from one animal to another. The results of these researches, however, although pathologically interesting, possess little, if any, practical value, inasmuch as they cannot be rendered available in the human subject.

Symptoms.—The symptoms attendant upon necrosis, in its earlier stages, have already been pointed out; those which accompany the separation of the old bone and the formation of the new, are, in general, sufficiently characteristic. The most important of these are, little ulcers, surrounded by large, unhealthy granulations, arranged in a papilla-like manner; sinuses leading from these ulcers down to the dead bone; and a discharge, more or less constant and copious, of thin, fetid, sanious matter, or of thick, white, inodorous pus; accompanied, in all cases, by a certain amount of hardness and swelling, pain and tenderness on pressure, wasting of the soft parts above and below the seat of the disease, and marked impairment of the functions of the neighboring joints. The general health always suffers; the patient is wan and emaciated; and, if the irritation is at all extensive, there will usually be hectic fever. In some cases the end of the sequester protrudes at one of the cloacae, thus at once declaring the true nature of the complaint; but, more commonly, the dead bone is completely imprisoned by the new, and can only be reached by the probe or finger, carried along the sinuses leading from the surface to the cloacae. In order to ascertain whether the separation has been effected, or whether the dead bone still maintains its relations, in some degree, with the living, the surgeon may often advantageously use two probes, introducing one at each extremity of the eschar, and moving them alternately in different directions, as may frequently be easily done when the detachment is complete. In general, also, useful information, in this respect, may be obtained from a consideration of the history of the case, as the size of the affected bone, the age of the patient, and the commencement of the attack. Thus, other things being equal, it will usually be found that a small bone will be more readily separated than a large one, and the bone of a young subject than that of an old one, while in every instance the process may be supposed to be more advanced in proportion to the period that has elapsed since the death of the bone.

A sequester or loose piece of bone occasionally causes serious mischief by its pressure upon neighboring structures, especially the nerves and bloodvessels, giving rise, perhaps, on the one hand, to severe neuralgia, and on the other, to more or less copious hemorrhage. The latter accident is most likely to occur from erosion and perforation of the popliteal artery in necrosis of the lower extremity of the femur; but it has also been met with in the anterior tibial artery, and even in the artery of the tongue, in connection with necrosis of the lower jaw.

Prognosis.—The prognosis of this disorder is variable. In general, it may be considered to be favorable when it is owing to external or local causes; when it is confined to the outer portion of a bone, the necrosis occurring in the form of an exfoliation; when it is simple and of moderate extent; and when the patient is young, robust, and of good constitution. On the other hand, the cure is difficult, and the issue doubtful, when the disease is acute, extensive, or complicated with other affections; when it attacks pieces which are of high importance on account of their function or situation, as those of the skull; when it occupies the interior of a bone, and involves several parts of it; when it arises from an internal or constitutional cause, as struma or syphilis; when it extends into the adjacent joints, especially when they are of large size; and, lastly, when the patient is enfeebled by age, long suffering, or previous disease. The most common causes of death are erysipelas, pyemia, and profuse discharge.

The time required for the separation of the eschar and the development of the sub-

stitute bone will depend, as already stated, in great measure, upon the situation and extent of the disease, the age, health, and the condition of the patient, and various other circumstances not admitting of definite statement. That the whole of a necrosed bone may be regenerated is a fact so well established as not to admit of any doubt. The new bone, however, as intimated elsewhere, is always, at best, only an imperfect copy, although, as regards its functions, it usually answers the purpose well enough, both as it respects its length and thickness, especially the former, which is usually equal to the old, or the original piece. When the substitute bone, during its development, is subjected to strong muscular contraction or made to bear too heavy a weight, it is very apt to become crooked, and hence all such mishaps should be carefully guarded against.

Treatment.—Although the treatment of necrosis must of necessity depend very much upon circumstances, there are three indications which deserve special attention; the first is to limit and moderate the inflammation which is the immediate cause of the mischief, the second, to watch nature during the separation of the old bone and the formation of the new, and the third, to promote the removal of the sequester, slough, or eschar.

The first of these objects is to be attained by the proper employment of antiphlogistic remedies; by the lancet, if the patient be plethoric, laxatives, antimonial and saline medicines, light diet, repose, and the free use of opiates to allay pain and induce sleep. The affected parts, placed in an easy, elevated position, are leeched and fomented, or, what is particularly serviceable, painted with a strong solution of iodine at least three times in the twenty-four hours, the surface being protected in the intervals with an emollient, anodyne cataplasm, or medicated water-dressing. In some instances, great benefit is derived from the application of a blister large enough to encircle nearly the whole of the affected limb, and kept on sufficiently long to produce vesication. By these means, the surgeon not only limits the inflammation, but promotes the absorption of effused fluids, and hastens the suppurative crisis, which is always inevitable, to a greater or less degree, in every case of this kind. As soon as fluctuation is perceived, or even before, if there be inordinate pain and tension, or deep-seated matter, a large incision is made at one or more points, in the direction of the long axis of the bone, in the hope of saving osseous as well as soft tissue, especially the periosteum, the integrity of which is so essential to the development and formation of the substitute bone. In making the opening, due attention is, of course, given to drainage, and to the prevention of its premature closure.

The second indication is to watch the part and system during the sloughing process and the stage of repair, to enable them to bear up under the trying ordeal. The case requires active vigilance rather than active treatment; care, on the one hand, that the disease do not spread, and, on the other, that the debility consequent upon the drainage and irritation do not obtain the mastery, and so bring on fatal exhaustion. A certain amount of inflammation must necessarily attend both operations, and, therefore, action must not be too much repressed, lest nature be thwarted in her efforts. A nutritious diet will generally be required, and the patient will often be immensely benefited by animal food and milk-punch, ale, porter, or wine, and the use of quinine, iron, and aromatic sulphuric acid, especially if there be hectic fever and night sweats. Gentle exercise should, if the strength will permit, be taken daily in the open air upon crutches; or, if this be impracticable, he should be pulled about in a hand-car, or swung in a hammock. Attention is, of course, paid to the bowels and secretions. Pain is allayed with anodynes. The principal local remedies are leeches, provided there is any disposition to overaction, the daily application of iodine, and the use of the bandage to support not merely the affected parts, but also the distal portion of the limb, which, when this precaution is neglected, has usually a tendency to become œdematous. Fetor is allayed, and discharge moderated, with chlorinated sodium or permanganate of potassium, introduced with the syringe and sprinkled upon the dressings. Much has been said about the employment of solvents, thrown in through the principal sinuses upon the dead bone, in the hope of promoting its gradual disintegration and elimination. Special stress used to be laid upon various acid solutions, particularly the nitric, hydrochloric, and pyroligneous; but experience has proved that they are always productive of harm, from their irritating effects upon the new bone and the soft parts, whilst, unless they are intolerably strong, they can exert no destructive influence upon the sequester itself. If such lotions be employed at all, they should, therefore, be employed in the mildest possible form, simply with a view to their detergent and alterant effects, which are often very salutary, expediting the sloughing and restorative processes. In general, however, all the good that can be expected to result from such remedies may be accomplished by injections of tepid water, impregnated with castile soap, a little potassa, or common salt, followed, if there be much fetor, by a weak solution of

some deodorizer. If new abscesses form, they must, as already mentioned, meet with prompt attention.

During this stage, a stage of comparative inactivity, inquiry is made into special diatheses, or states of the system. The patient, if strumous, may be in need of special remedies; or his system may be impregnated with the syphilitic poison, and a course of mercury, or of iodide of potassium, may be required. It must be obvious that no satisfactory progress can be made towards a cure so long as the system is borne down by a vitiated state of the solids and fluids.

The third indication is to get rid of the sequester, for so long as this remains it must necessarily keep up inflammation and discharge, the latter of which is generally not only highly offensive, but often so copious as to establish a serious drain upon the system. It was commonly supposed, until recently, that the dead bone, during its sojourn among the living tissues, was acted upon by the absorbent vessels, so as materially to diminish its size and weight, the idea having, apparently, derived support from the altered and pitted condition of the surface of the affected piece. This notion, however, was completely dispelled by the experiments of Mr. Gulliver, who ascertained, as might, indeed, have been anticipated, that such an occurrence is altogether impossible. Portions of necrosed bone, carefully weighed before and after exposure, were confined on suppurating surfaces, in the medullary canal, and in the subcutaneous connective tissue, for months, and in one instance for upwards of a year, without undergoing the slightest alteration whatever.

Inasmuch, then, as the dead bone acts as an extraneous body, and is no wise amenable to the agency of the absorbents, the indication plainly is to remove it by operation. Such a step is the more imperative because of the manner in which it is imprisoned, the substitute bone forming a firm, solid case around it, and thus effectually preventing its extrusion. The only circumstance which should make the surgeon at all hesitate is the doubt that may arise in his mind respecting the probability of the dead bone being completely detached, and the new one sufficiently advanced to enable it, after the removal of the sequester, to maintain its position without bending under the weight of the limb, in turning in bed, walking, or sitting. If he is satisfied of this, as he usually may be after a careful examination, the operation should at once be proceeded with. The instruments that will be required are several scalpels, a trephine, a Hey's saw, an elevator, pliers, chisels, gouges, and stout forceps, with a good syringe for washing away osseous débris. The adjoining cuts represent some of the more important of these instruments. Bonwill's surgical engine often affords valuable aid in operations on the bones. The different steps of the procedure will be greatly facilitated by the use of the elastic bandage, which, while it effectually prevents bleeding, enables the surgeon to do his work more rapidly and more thoroughly.

The incisions should be made in the direction of the long axis of the bone, out of the way of the great vessels and nerves. The best plan is usually to select one of the principal cloacæ, or, when two or three are close together, especially if they are on the same plane, to connect them, thereby affording more room to work in. When the soft structures are much diseased, they may be included in an elliptical incision, as, in this event, it may be best to get rid of them. When it is deemed advisable to connect two or more cloacæ, the object may easily be attained by a Hey's saw, the circular saw of the surgical engine, or, if the new bone is not very thick and firm, by the pliers. The trephine is chiefly of use when the openings in the substitute bone are very small, or when this bone possesses unusual density and thickness, rendering its division extremely difficult by the more ordinary instruments. Access having thus been obtained, the sequester is to be seized by one of its extremities, with a pair of forceps having long, thin blades, serrated on their inner surface, and from a third of an inch to half an inch in width, the handles being well curved, so as to facilitate prehension and maintenance. In executing this step of the operation great care must be taken not to press the extremity of the sequester into the soft parts, on account of the danger of wounding important vessels and nerves. Such a precaution is especially important in removing dead bone from the lower end of the femur, on account of the proximity of the popliteal artery.

When the sequester is unusually long, it may be necessary to bisect it, and extract each piece separately; an operation which is always easily performed with the pliers or chisel.

The dead bone having been removed, the next step is to scrape away the semiorganized granulations from the inner surface of the new bone, and to wash out the canal with the syringe and cold water, in order to free it completely of any débris that may have

been left behind. Unless this be done, a long time may elapse before the canal takes on healthy action, as the old granulations are too feeble to furnish reparative material.
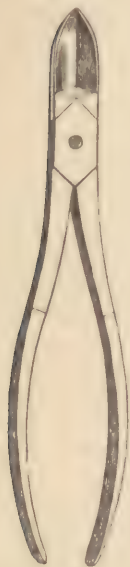
Fig. 385.　　　Fig. 386.　　　Fig. 387.　　　Fig. 388.　　　Fig. 389.

Instruments for removing Dead Bone.

The hemorrhage after the removal of the elastic bandage is usually very free, the blood oozing out at every point, in consequence of the great vascularity of the parts, both

Fig. 390.　　　Fig. 391.

Hammer.　　　Gouge.

osseous and soft, and occasionally requires plugging of the cavern with lint steeped in some styptic lotion, as a weak solution of subsulphate of iron, alum, or alum and tannic acid. It is seldom that any arteries require to be tied.

The edges of the wound are drawn lightly together with adhesive strips; the limb, placed in an easy position, is bandaged from the distal end upwards; and the parts more immediately affected are kept constantly wet with cold water medicated with laudanum and acetate of lead. The dressings are removed in forty-eight hours, when the wound is well syringed, and covered with an emollient poultice, to favor the granulating process. The only general means usually required are light diet and a little attention to the bowels, with a full anodyne after the patient is put to bed. If the new bone is not sufficiently strong to prevent the limb from bending or breaking, it must be supported by appropriate splints, or, what is better, a case made of sole-leather, gutta-percha, or trunk-maker's board. Extension and counter-extension may be necessary when there danger of shortening, as in necrosis of the thigh or leg. Ankylosis of the neighboring joints should be prevented or counteracted by passive motion.

The cicatrization will be greatly facilitated, after such an operation, if the edges of the cloacæ and sinuses be thoroughly pared before the parts are dressed, as they will thus be placed in a much better condition for the rapid development of healthy granulations. In general, the edges of such openings will be found to be livid, undermined, and partially devitalized, and, therefore, incapable of throwing out healthy material.

Soon after the sequester has been removed, whether by nature or art, the new osseous

shell begins to contract, and by degrees assumes the shape of the old bone, which it is designed to replace. While this change is going on externally, osseous matter is deposited upon the inner surface of the shell, as well as upon the articular ends of the surviving portions, thereby gradually filling up the cavity, the period required for this being generally in proportion to the size of the eschar. The medullary canal, in case there has been one, is, as already stated, seldom reëstablished.

It is not often that the surgeon is not able to effect a good cure in necrosis; in general, even with little deformity and loss of function. Cases do, however, occur, where, from neglect or injudicious treatment, the neighboring structures are so extensively and ruinously involved as to render it difficult, if not impossible, to save the affected limb. Such an event will be particularly liable to happen when a large joint is implicated, as, for instance, that of the knee in necrosis of the thigh, or of the ankle in necrosis of the tibia. Under such circumstances, hardly anything short of amputation will be likely to answer; and a similar procedure may become necessary when the patient's constitution is so much shattered by previous or concomitant disease as to preclude the possibility of its holding out during the time that may be required for the separation of the dead bone. In other cases, again, amputation may be demanded on account of hemorrhage from some large sinus, presenting itself either as a general oozing, or as a flow from an artery of considerable size, opened by ulcerative action at a period when the loss of a few more ounces of blood might prove fatal. Another reason for such interference is excessive deformity of the limb, rendering it not only very unseemly, but utterly unserviceable. It is impossible, however, to exercise too much caution in attempting to decide so grave a question. In weighing the several points involved in its consideration, we must not lose sight of the fact that cases, apparently of the most forlorn character, where life literally hangs, as it were, by a thread, will sometimes promptly recover upon the removal of the dead bone.

Resection of bone deprived of vitality may occasionally be advantageously practised instead of its removal in the form of a sequester. Such a procedure is especially indicated in young subjects exhausted by previous suffering, where delay would be likely to be followed by great damage to the constitution, if not destruction to life. Another advantage is that the periosteum may often be much better preserved than when the disease is left for several months to itself, as it must generally be when the bone is detached spontaneously. This whole subject has been placed in a very favorable light by Ollier, who, in in his great work, etitled Traité Expérimentale et Clinique de la Régénération des Os, published in 1867, has adduced a number of cases illustrative of the beneficial effects of this mode of treatment, derived chiefly from the practice of Larghi, Creus-y-Manzo, Jambon, Lentenneur, and T. Holmes, in all of which large portions of bone were removed, with the effect of useful limbs. Other instances, equally gratifying, have since been furnished, among others, one by Dr. Cheever and one by Dr. Buckingham, of Boston. The bone which yields the best results under this mode of treatment is the tibia, although it is applicable to every piece of the skeleton. Excision of the shaft of the tibia, however, is always followed, as was first pointed out by Ollier, by dislocation of the fibula at the superior tibio-fibular articulation, in consequence of the contraction of the muscles of the leg, whereby the head of this bone is gradually pushed beyond its natural level. This change was strikingly manifest in the case reported by Dr. Cheever. To counteract this tendency, proper mechanical appliances should be employed to insure perfect quietude of the limb until the parts are healed.

It occasionally happens that nature fails to repair the loss after the removal of the dead bone. In a case of this description, occurring in a child four years of age, in which two-thirds of the humerus were wanting, Dr. MacEwen, of Glasgow, transplanted small fragments of wedges of bone, obtained from the curved tibiæ of other patients, into the soft tissues, in the position of the deficiency, with the result of filling the gap with a new shaft, the limb being only half an inch shorter than its fellow. This ingenious practice has been imitated by Mr. Macnamara, of London, who inserted several grafts taken from an amputated metatarsus into a groove prepared in the leg of a child, from whom he had removed, some months previously, the greater part of the shaft of the tibia, but with what result I am not aware. That this operation is perfectly feasible is shown by some recent experiments of Bruns, in which the power of the cells of the medulla of the Haversian canals to form new bone is conclusively demonstrated.

SECT. X.—SOFTENING.

The essential characteristic of osteomalacia, mollities ossium, or softening of the bones, is a diminution of the firmness and solidity of the osseous tissue, depending upon the gradual removal of its earthy constituents, and the increase in its medullary elements. The disease is often confounded with rachitis, but differs from it in the circumstances, first, of its being a disorder of adult life, and, secondly, in being always attended with severe pain; whereas rickets is peculiar to infancy, and free from local suffering.

Fig. 392.

Madame Supiot, in a Posture quite practicable in the advanced Stage of the Disease.

Softening of the osseous tissue varies in degree and extent, occurring at one time as a very slight affection, with hardly an appreciable change of structure, and at another as a most serious lesion, in which it is difficult to distinguish any trace of the normal substance. In regard to its extent, it may be general or partial; in the one case pervading the entire skeleton, while in the other it is limited to particular bones, or even a portion of bone. Of general osteomalacia, the case of Madame Supiot, so minutely described by Morand, the younger, in the Memoirs of the Academy of Sciences of Paris, for 1710, affords a characteristic, as well as a most extraordinary, example, as shown in fig. 392. In this woman, who died at the age of thirty-seven, the bones were so completely softened that they could be bent like wax, and put in almost any position, although she herself had lost all control over them, her head and left arm being the only parts she could move. Most generally the disorder is confined to particular bones, as the ribs, sternum, vertebræ, and the pelvic pieces, the latter being especially liable to suffer in child-bearing women.

The osseous tissue in this disease gradually loses its firmness and solidity, becoming decalcified and ultimately so soft and pliant that it may be easily bent, if not cut. It is of a pale reddish color, often inclining to yellow, is specifically lighter than the healthy structure, and is infiltrated with a turbid, viscid serum, removable by pressure. Occasionally the osseous fibres are widely separated from each other, so as to leave large cells, which are filled with a bloody-looking, adipose substance, as seen in fig. 393. When this is the case, the bone is sometimes remarkably pliant, bending like semiconcrete wax. Boiling completely dissolves it; and exposure to the air, by abstracting its moisture, sensibly diminishes its weight. Such are the principal changes observable in the osseous tissue. The periosteum over the affected part is abnormally thick, rough, and but feebly adherent; it is of a grayish hue, deeply injected, and, like the bone, infiltrated with sanguinolent matter. Upon being macerated, however, it is found to retain its fibrous structure. The marrow is converted into a reddish, greasy sanies, and the medullary membrane is wasted away to a few soft, connective shreds. The cartilages sometimes participate in the softening, while the muscles are pale, atrophied, and infiltrated with a reddish fluid.

Fig. 393.

Section of a softened Femur; the Medullary and Cancellous Structures are occupied by a Transparent jelly-like Fat, of various Colors.

In the advanced stages of the disease, the bone is deprived of its laminated structure, the osseous corpuscles are greatly changed in their shape, as well as diminished in number, and the Haversian canals are enormously swollen and distended. The red, grumous substance, so abundantly diffused through its interior, has been shown by Dalrymple to consist of granular matter, nucleated cells, and caudate corpuscles.

The softening generally involves the whole thickness of the bone; but cases occur in which the outer table remains unchanged, consisting of a thin, brittle shell. The disorder obviously consists either in an inordinate absorption of the phosphate of lime upon which the solidity of the osseous structure naturally depends, or in a deficient deposition of this

matter into its meshes. Dr. Leeson, who has carefully investigated this subject, has found a specimen of softened bone to be composed of 18.75 of animal matter, 29.17 of phosphate and carbonate of lime, and 52.08 of water. As a general rule, it may be stated that there is always a notable increase of fatty matter, a diminution of phosphate and carbonate of lime, and an increase of animal substance.

Respecting the *causes* of osteomalacia our information is entirely at fault. It is generally supposed, and not without reason, that a gouty, rheumatic, syphilitic, or scorbutic state of the system predisposes to the occurrence. However this may be, it is evident that the disease is essentially connected with, if not directly dependent upon, a vitiated and depraved condition both of the solids and fluids; but whether the disorder of the one precedes that of the other, or whether they have a simultaneous origin, and afterwards keep steady and regular pace with each other, are questions which our knowledge is inadequate to solve. Whatever the real causes may be, it is a well ascertained fact that inflammation plays a most important part in the production of the changes which characterize it. If it were not so, how could we account for the excessive vascularity of the affected tissues, the sanguinolent nature of the infiltrated fluids, the thickened, spongy, and congested condition of the periosteum, and, finally, the atrocious and constant pains which form so notable a feature in the history of osteomalacia? All these circumstances unerringly point to inflammation as the great agent in the production of these changes; changes which, when existing in the soft structures, are invariably referred to this cause, and to none other. The morbid action, whatever it may be, is always of a chronic character, and is attended with important lesions of nutrition, leading to the removal of the earthy matter of the bones, and the excretion of it from the system, or its deposition among parts where it does not naturally occur. Or, what is more probable, there is both absorption of the original solid structure and a want of secretion of new, thus causing a complete disintegration, or decomposition, of the osseous tissue. All these circumstances are sufficiently obvious and tangible; but if we attempt to go beyond them, we involve ourselves at once in difficulties from which it is impossible to extricate ourselves.

Osteomalacia is rarely seen before the age of puberty, its favorite period of attack being between the thirtieth and fiftieth years. Another singular feature in its history is that it is much more frequent in women than in men, in the proportion, it has been said, of ten to three. Of 145 cases collected by Litzman, only 13 were males. It is most common in females who have borne several children; and it often begins either during pregnancy, or within a short time after parturition. Of the above cases, 91 were of this description. Examples have been reported in which it was hereditary, having been distinctly traced through three generations, but in none of the offspring did it show itself until after puberty. The bones of insane persons are frequently in a softened condition, approaching that of osteomalacia. At the Carmethen Asylum, as stated by Dr. Hernder, of twenty bodies examined after death, the ribs in nine were found to be abnormally soft and fragile.

The *symptoms* of this disease vary in its different stages. Its invasion and progress are generally very insidious. The earliest, and for a long time the most prominent, occurrence is pain in the limbs, spine, and pelvis, of a wandering, shifting character, which the patient usually supposes to be of a rheumatic nature, and which is often so severe as to cause immense distress, especially at night, and in damp, chilly states of the atmosphere. By and by, dyspnœa sets in, with palpitation of the heart, and a sense of constriction across the chest, and the patient is seized with an overwhelming feeling of prostration, which utterly unfits him for business, and usually compels him to keep his bed. If he attempts to walk, his limbs bend under him, and if the effort is often repeated, they soon become badly curved; should his toe catch in the folds of the carpet, or should he be so unfortunate as to trip, or fall, or give his body a sudden twist, he will probably hear some of his bones crack, and yield under the superincumbent weight. Emaciation gradually takes place, the appetite is deranged, the skin is bathed with clammy perspiration, the tongue is foul, the bowels are irregular, being either costive or too loose, and the urine, surcharged with earthy phosphates, is very thick, heavy, of a whitish aspect, and frequently also albuminous. In the latter stages of the malady, the saliva, tears, and sweat often contain similar ingredients. Great distortion frequently occurs; and the bones, bent in every direction, are effectually disqualified for the performance of their functions. The chest projects like that of a pigeon, the spine is bent laterally, as well as backwards, the pelvis is twisted, or rotated upon its axis, and the whole stature of the individual is sensibly diminished, the head being thrust down between the shoulders, which are unnaturally arched and prominent. Amidst all this disturbance, however, the intellect is unclouded, menstruation is perfect, and even conception is still possible. The period at

which death occurs varies from a few months to several years, its approaches being usually very gradual, and the consequence of sheer exhaustion.

The *diagnosis* of osteomalacia cannot always be very clearly defined. The disease for which it is most liable to be mistaken is rachitis, but from this it may generally be distinguished by the following circumstances :—Osteomalacia rarely occurs before the age of twenty-five or thirty, while rachitis is altogether peculiar to infancy and childhood, the disease in the former attacking the bones after the completion of ossification, whereas in the latter it assails them before they are fully developed. In softening, the patient is harassed with excessive pain and an overwhelming sense of exhaustion ; in rickets, on the contrary, there is a total absence of pain, and the little patient generally retains a good share of strength. In osteomalacia there is more deformity than in rachitis ; the disease is also of a more fatal character, few persons getting well, whereas in rachitis recovery is the rule, death the exception. Softening is much more common in women than in men, especially in such as have had several children ; rachitis, on the contrary, is nearly equally frequent in both sexes. In softening the urine always contains a large quantity of earthy matter, whereas in rickets this excretion is unusually laterititious. Finally, the two affections are signalized by marked differences in their anatomical characters. In osteomalacia the osseous structure is completely disintegrated and decomposed ; in rachitis, on the other hand, it is merely modified, and, therefore, susceptible of restoration.

The *prognosis* of osteomalacia is generally so unfavorable that Solly, Dalrymple, and some other authors are inclined to regard it as of a truly malignant character. Although this opinion requires confirmation, it serves to show how exceedingly unmanageable the disease has hitherto proved to be in the hands even of the best practitioners. The period at which death occurs is very variable, some patients dying in a few months, others not under several years.

The great point in the *treatment* of osteomalacia is to improve the general health by a well-regulated diet and by the employment of tonics, as iron and quinine, the shower-bath, and change of air. Mercury has occasionally been administered, and carried to the extent of ptyalism, but, instead of proving beneficial, it has usually been productive of injury by still further exhausting the powers of life. Phosphate of lime, as having a tendency to supply the deficiency of osseous matter, has also been tried, but apparently with no better effect. If we adopt the idea that the disease is of an inflammatory nature, antiphlogistics ought to be advantageous, but thus far their employment has yielded no good results, but rather the reverse. When the disease is fully established, confinement in bed upon a soft, elastic mattress will be necessary ; and every precaution should be taken to avoid the occurrence of curvature and fracture of the affected bones. Pain must be relieved by the liberal use of anodynes.

Fig. 394.

Rickets.

SECT. XI.—RACHITIS.

Rachitis, or rickets, is a disease of the osseous tissue, consisting in a deficiency both of its earthy and organic elements, as is shown by the diminished quantity of phosphate and carbonate of lime, and the absence of gelatin, which form such important constituents of normal bone. The consequence is that the different classes of bone, the long, short, and flat, become so excessively softened as, in time, to yield under the slightest pressure, bending and twisting in various directions, and thus occasioning serious and generally irremediable deformity, as observed in the drawing, fig. 394, taken from a patient at the Philadelphia Hospital.

Rickets, essentially a disease of early infancy, is most frequently witnessed from the eighteenth to the twentieth month, although many cases occur before the end of the first year. Now and then an instance is observed as late as the twelfth year ; but this is extremely uncommon, and altogether contrary to the usual course of the affection. Occasionally it is congenital. The influence

of age in the production of this affection is well shown by the combined statistics of Bruennische, Von Rittershain, and Ritsche, which indicate that of 903 cases, 358 occurred during the first year, 342 during the second, 134 during the third year, 31 during the fourth, 17 during the fifth year, and 21 from the sixth to the ninth. Instances have been noticed in which it seemed to be hereditary, or in which it attacked several members of the same family.

From the accurate and masterly account of this disease by Glisson, published upwards of two centuries ago, it appears that it first took its rise about the year 1620, in the western parts of England, from which it gradually spread over the rest of Europe. In this country it has always been extremely uncommon, even among the lower classes, whose children are its most frequent subjects. An exception, however, to this statement occurs in regard to the children of some of our eleëmosynary institutions. Thus, according to Dr. Parry, in the Philadelphia Hospital, 25 per cent. of all the children between two months and four years of age are rickety ; and in some of the foreign institutions, as in those of London, Prague, and other cities, the proportion is still greater. These differences are doubtless due to the differences of constitution, and modes of living, children that are crowded together, ill-fed, and confined in small, ill-ventilated apartments, being most liable to suffer from the disease.

Of the *causes* of rickets nothing is known. From the circumstance of its appearing occasionally in several members of the same family, it has by many been supposed to be of a hereditary character, nearly all of the older, and not a few of the modern, authorities concurring in this view of its origin. How far a strumous, or scorbutic state of the system is influential in its production is undetermined ; nor is anything positive known of the effects of a vitiated atmosphere upon its development, as living in damp, crowded, and ill-ventilated underground apartments, so prejudicial to the general health. That these and other causes may engender it when there is a predisposition to its occurrence is highly probable, but then the question arises, What creates the predisposition ? There must necessarily be some defect in the constitution, otherwise the disease could not take place. Mere disorder of the digestive and assimilative functions could not produce it, for thousands of children are thus affected, and yet do not suffer from rickets. A syphilitic taint of the system is a powerful factor in its production, as is shown by the fact that the majority of children born with congenital syphilis become ricketty despite the best nursing ; and Parrot, one of the latest writers on the subject, teaches that the disease can be traced to no other cause. Whatever the exciting cause may be, there is no question that the immediate one is a deficiency of phosphate and carbonate of lime, upon which the solidity of the osseous tissue essentially depends. How far the want of cartilage, which is such an important element of healthy bone, may disqualify the osseous tissue in rachitis for the reception of earthy matter, is a problem which remains to be solved.

The *pathological* alterations of the osseous tissue consequent upon this disease may be conveniently arranged under three heads, each possessing marked peculiarities. In the first, the bones are saturated with a reddish, watery fluid, a considerably quantity of which is also interposed between their outer surface and the periosteum, on the one hand, and between the medullary membrane and their internal walls, on the other. At a more advanced period, this fluid is replaced by a sort of gelatiniform substance, which becomes gradually organized, and ultimately adheres with great firmness to the parts with which it lies in contact. The periosteum is thickened and injected, the nutrient vessels are remarkably enlarged, and the medullary membrane is very spongy and vascular. The lamellæ of the long bones, naturally so hard and compact, are a good deal softened, while the areolar structure is greatly rarefied, many of the cells being more than double the natural size. Similar alterations are observed in the short and flat bones.

In the second stage, a peculiar spongoid substance is formed between the periosteum and the outer surface of the bones, varying from two to three lines, or upwards, in thickness. When the quantity of this "transition tissue" is unusually great, it may exert such a degree of pressure upon the lamellæ of the compact tissue as to push them inwards towards the medullary canal, in such a manner as to reduce it very materially in size, if it do not entirely obliterate it. Simultaneously with these changes the bones are rendered so soft that they may easily be bent, cut, and even indented with the finger.

In the third stage, that of resolution, the recently formed substance in the long bones, as well as in some of the flat and short, assumes a compact character, and is gradually identified with the preëxisting tissues, which at the same time regain their primitive solidity. Owing to the presence of this new matter, the bones are much larger than in

their natural state, and their firmness, especially in the adult, resembles that of ivory. Hence the term eburnation is sometimes applied to this condition.

When rachitis proves fatal, the body is usually found in a state of excessive emaciation; the muscles are thin, pale, and flabby; the ligaments are relaxed; the adipose matter is almost entirely consumed; the cerebral substance is unnaturally soft; the liver and spleen are enlarged and flaccid; the intestines are attenuated and distended with gas, and there is not unfrequently marked tumefaction of the muciparous follicles; the mesenteric glands are increased in volume and consistence; the heart is softened, and smaller than common; the lungs, which are often congested, are more or less tuberculized in about one-sixth of the cases; and the bronchial glands are hypertrophied, loaded with serosity, and of a deep purplish hue. Occasionally there is partial ossification of the arteries, muscles, and other structures, as if they had become the recipients of the earthy matter which naturally appertains to the bones.

The *symptoms* of rickets possess nothing of a definite character in the earlier stages of the disease. Its approaches are generally stealthy, and at times almost imperceptible. The child, gradually losing its health and spirits, becomes dull and listless, and labors under derangement of the digestive organs, especially flatulence and colicky pains. When craniotabes exists, the child is very fretful, its sleep is disturbed, and it is liable to suffer from spasm of the glottis. After a while, marked emaciation sets in; the muscles are soft and flabby; the abdomen is tympanitic; the skin is dry and sallow; the face looks pale and doughy; the urine is scanty, turbid, and laterititious; and the alvine evacuations are thin, watery, and fetid, there being nearly always considerable diarrhœa. Bronchial catarrh is of frequent occurrence. Dentition advances slowly, and the teeth, of a black, fuliginous aspect, often begin to decay almost as soon as they pierce the gums. The fontanelles and sutures are unnaturally open, the occipital and posterior half of the parietal bones, especially, being thinned, and the seat of depressions or of open spaces from absorption of their plates, the pericranium and dura mater being in contact with each other; and the whole process of ossification is peculiarly slow and imperfect, sometimes, indeed, almost stationary, if not actually retrogressive. As the disease proceeds, the bones grow more and more soft, and, being unable to sustain the weight of the body or to resist the action of the muscles, are at length strangely and frightfully distorted. The head, although abnormally small, is disproportionately large to the size of the face, and is sunk down between the shoulders; the clavicles are bent and extremely salient; the spine is curved in various directions, especially laterally, and diminished in length; the pelvic bones are curved inwards, so as to lessen very materially the corresponding cavity; the ribs, thickened at their point of union with the costal cartilages, are flattened, and the chest, in consequence, is sensibly increased in its antero-posterior diameter, giving it a narrow, pigeon-shaped appearance. The bones of the extremities are shortened, bent, and twisted upon their axes, while their articular ends, or epiphyses, are softened, rarefied, and greatly expanded, thus appearing much larger and more prominent than naturally. If the child has begun to walk, he becomes daily more feeble on his legs: he waddles, trips, falls, and soon returns to his nurse's arms.

In rachitis there is an actual arrest of development of the bones, which, although it pervades the entire skeleton, is always most conspicuous in the lower extremities, the femur, tibia, and fibula being often fully one-third shorter than in the natural state, and also diminished in diameter, except at the epiphyses, which, as already seen, are always unusually large and prominent, especially if the child has been much on his feet. Under such circumstances, the head and neck of the femur are sometimes forced by the weight of the body into a horizontal position below the level of the great trochanter; the individual is bow-legged, and the joints of the knee and ankle suffer great distortion from the weakened and relaxed condition of their ligaments. The flat bones, during the reparative process, become solidified and hypertrophied in their areolar texture, while the long ones are increased in thickness and strength along the concavity of their curvatures, that they may be the better able to support the superincumbent pressure, and resist the effects of muscular action.

The only disease of the bones with which rachitis is at all liable to be confounded is osteomalacia, or softening. The signs of distinction, however, are commonly very evident. In the first place, rachitis is an affection of infancy and early childhood, whereas mollescence never occurs until after middle age. Secondly, in rickets the softened and flexible state of the skeleton is only temporary; after a time, a process of repair is set up, and gradually continuing, the affected tissues become at length more firm and compact than they are in the natural state; in osteomalacia, on the contrary, the disease, once be-

gun, generally progresses until the patient is worn out by his suffering, no attempt being usually made at restoration. Thirdly, in rachitis there is no material alteration in the urine, whereas in mollescence this fluid is always loaded with a large quantity of earthy salts, the kidneys taking on a vicarious action, and so carrying off the material destined for the supply of the bones. Fourthly, in rickets there is an actual arrest of development, in consequence of which the bones remain disproportionately short, thin, and dwarfish; in softening, on the contrary, the affected pieces retain their normal shape, although they are so changed in their consistence that they may readily be cut and bent in almost any direction. Lastly, in rachitis one of the earliest symptoms, as originally pointed out by Elsässer, and fully confirmed by Vogel, is the existence, on the posterior surface of the skull, of little depressions, pits, or hollows, varying in size from a linseed to that of a bean, easily detectable by the tips of the fingers, and having a soft, elastic feel, not unlike cartridge paper. In osteomalacia no such occurrence is found.

The *prognosis* of rachitis is generally unfavorable, few persons recovering without permanent deformity. In regard to the danger to life, it is commonly in proportion to the number of bones affected, the rapid progress of the complaint, and the age of the subject. Very young children are more liable to die of it than those who are more advanced in years, and those who are born of scrofulous or syphilitic parents than those who come into the world under more happy auspices. The duration of the disease is extremely variable; very tardy at one time, very rapid at another. In general, even under the most favorable circumstances, several years elapse before complete recovery occurs. The progress of the cure is often fatally arrested by some intercurrent malady, as measles, scarlatina, smallpox, or cholera. The longer recovery is postponed, the greater will be the danger of serious deformity. The duration of life is not necessarily shortened in persons who get well of rickets, as cases have occurred in which they attained the age of sixty, seventy, or even seventy-five.

Treatment.—In the treatment of rachitis active measures are out of the question. The chief reliance must be upon a properly regulated regimen and the use of tonics, with a view of invigorating the general system, and of improving the condition of the blood, which is always materially altered in its properties. Whatever, therefore, has a tendency to strengthen the patient, and to enrich the circulating mass, must prove indirectly beneficial in removing the disease, and should claim serious consideration in every case.

The diet should be mild and nutritious, comprising an adequate amount of nourishment in the smallest possible space, so as not to oppress the stomach and create flatulence and acidity. The best article is, of course, the mother's milk, or, when this is insufficient or unwholesome, fresh cow's milk, or, better still, the milk of the ass, which is now so much used in some of the larger cities of continental Europe, and which approaches nearer, in its composition, to human milk than that of any other animal. If the teeth are properly developed, a small amount of animal food will be useful, especially fat bacon, well boiled, and not too salt, with good stale bread, and a little mashed potato. The body should be washed at least twice a day with salt water, followed by dry friction, or rubbed with a moderately stiff salt towel; and, if the system is not too much reduced, cool or cold bathing will be found highly invigorating. Frequent exposure of the little patient to the fresh air, and exercise suited to his age and strength, are to be rigidly enforced. The secretions are improved by alteratives, especially blue mass and mercury with chalk, while the bowels are kept soluble with rhubarb, magnesia, or oil. Acidity is allayed by the alkalies, as lime water, soda, or potassa.

Tonic medicines, particularly quinine and iron, given in small doses, and long continued, with an occasional intermission for a few days, are always imperatively indicated, and there are few cases which are not promptly benefited by their exhibition, especially in the early stages of the disease, although they are nearly equally useful throughout its entire progress. The mineral acids, and the tincture of the chloride of iron, are particularly advisable when the disease is associated with a scorbutic condition of the system. Alterative doses of mercury occasionally exercise a salutary influence, especially when the patient labors under the strumous diathesis, the best form being the bichloride, in combination with a small quantity of iodide of potassium, given in syrup of orange peel. The pain, which is often considerable, is controlled with opiates, either alone or conjoined with diaphoretics.

Lately, the phosphates, formerly so much employed in the treatment of rachitis, on the ground that they would tend to supply the deficiency of earthy matter, have again come into vogue, but it remains to be seen whether they really possess any advantage over the

more ordinary tonic remedies, already referred to, or whether, indeed, they are not inferior to them.   Their best form of exhibition is the syrup.

Of all the so-called antirachitic remedies, however, the most valuable, so far as any individual article is concerned, is cod-liver oil, given several times a day, in doses suited to the age and other circumstances of the patient.   Possessing highly nutritive and alterative properties, it is admirably adapted to support the system, to enrich the blood, and to improve the secernent powers, which are so much at fault in rachitis.   It may be administered either alone or in union with some of the more important tonics above mentioned.

The mattress upon which the child lies should be perfectly free from hollows or depressions, it being a matter of the first moment that the head, trunk, and limbs should rest upon the same plane.   As soon as softening occurs, support must be afforded to the weakened structures by appropriate mechanical appliances.   The erect posture and progression must be interdicted until the bones are sufficiently strong and firm to bear the weight of the body.

The angular deformity left after recovery from this disease is not only very unseemly, but often a serious impediment to progression, and, therefore, demands surgical interference.   When the bones are still soft, the object may generally be attained by forcible extension, performed in a direction opposite to the projection, with the precaution of preventing separation of the epiphyseal connections.   When the reverse is the case, subcutaneous osteotomy must be performed, the division, as stated in the second volume, being effected by means of a saw, trephine, chisel, or dentist's drill, and rectification produced by suitable apparatus, or the use of the plaster bandage.

SECT. XII.—FRAGILITY.

Fragility of the osseous tissue is one of those affections which are to be regarded rather as an effect of disease than as a disease itself.   It consists, as the name implies, in a peculiar brittleness of the bones, in which, especially in its more advanced stages, their substance is so completely changed in its character as to give way under the most trivial circumstances.   All the bones are liable to this morbid brittleness, and cases occur, although rarely, where it literally pervades the whole skeleton.   In 1857, the body of a female, supposed to be upwards of seventy years old, was brought into the dissecting rooms of the Jefferson Medical College, with upwards of eighty fractures, received a few days before in a fall from a third story window upon the pavement below.   Nearly all the ribs, several of the vertebræ, and a number of the long bones, were broken, and signs of former fractures existed in the humerus, thigh, scapula, and other pieces.   Devergie examined the body of a woman who died under symptoms of fragility, in whose skeleton there were not less than eighty-three fractures.   The late Professor William Gibson met with a young man, whom I also saw many years ago, the bones of whose extremities were repeatedly broken by the most trivial accidents.   The clavicles had suffered still more frequently, having been fractured altogether eight times.   This universal fragility of the osseous tissue occasionally occurs at a very early period; sometimes, indeed, even in the fœtus in the womb.   Chaussier met with a remarkable example of this kind, where the long bones had experienced not less than one hundred and thirteen fractures, some being perfectly consolidated, thus showing that they had taken place some time previously, while the rest were either recent or had partially united.   The child survived its birth only twenty-four hours.   General fragility, however, is a comparatively rare affection; usually the disease is limited to particular bones; or, still more commonly, to particular portions of a bone; and those which are most prone to suffer are the head and neck of the femur, the ribs, sternum, radius, ulna, clavicle, and the superior extremity of the humerus.

When the affection exists in its highest degree, the slightest accident is frequently sufficient to produce fracture, as a severe fit of coughing, kneeling upon a hard floor, or turning round in bed.   Sometimes, indeed, the fragility is so great that the individual cannot be touched rudely without the occurrence of the injury.   Of this description was the memorable case of the woman, recorded by Saviard, who could not be moved about in bed without breaking some of her bones.   After a confinement of six months she died, when it was found that she had had fractures in all the long bones of the extremities, as well as of the clavicles, ribs, vertebræ, and pelvis, many of the pieces being so brittle that they could not be handled without crumbling into fragments, similar to old, dry bark.

Fragility of the bones usually comes on without any assignable *causes*, and the general

health not unfrequently remains good until long after it has made its appearance. In most cases, if not in all, it is merely symptomatic of some other disease, particularly of rheumatism, gout, syphilis, scrofula, and scurvy, attended with an altered and impoverished state of the blood, and impairment of the assimilative powers. The bones themselves are very much in the condition in which they are in osteomalacia, that is, they are more or less softened by the removal of their earthy matter, and often so completely saturated with fat as to render them unfit for preparations. On the other hand, however, they are sometimes remarkably dry and brittle. These facts show that their intimate structure undergoes some important anatomical change, the immediate result, apparently, of inflammation. What tends to support this view of the nature of the affection is the circumstance that, long before the bones manifest any disposition to break, the patient is harassed with severe pains, deep-seated, fixed, and referred to particular portions of the skeleton, and that, upon dissection, the diseased parts are generally found to be extremely vascular, their areolar tissue being profoundly injected and infiltrated with bloody matter, while the periosteum is very thick, spongy, and highly congested.

Fragility of the bones is one of the usual concomitants of old age. As life advances, their vascularity sensibly diminishes, many of the vessels shrinking, and becoming finally entirely obliterated. It is owing to this circumstance that old persons, especially females after the fifty-fifth year, are so much more liable to fracture than to dislocation, the part most prone to yield being the neck of the femur within the capsular ligament, whose areolar tissue is often astonishingly rarefied, while the compact is hardly as thick as ordinary letter paper. A fatty and brittle state of the bones is not uncommonly an effect of general paralysis.

This disease is sometimes observed in several members of the same family. In an instance related by Dr. Pauli, of Landau, it was distinctly traceable through three generations on the father's side. All the grandchildren, five in number, had each had several fractures, one as many as five, in the bones of the extremities, mostly as the result of inconsiderable injury. They were all remarkably healthy, without any evidence in any of them of a scrofulous taint of the system.

An instance of a similar kind was recently communicated to me by Dr. H. L. Battle, of Wadley, Georgia. Of a family of eleven children five, all boys, have inherited this peculiarity, evidently through the mother's side, although she has never suffered from fractures. She is affected, however, with curvature of the spine, and her father and several of her brothers and sisters have fragility of their bones. All the unsound children resemble their mother in complexion and in the color of their eyes. The oldest, now twenty-four years of age, has had sixty-four fractures; the next, two years younger, thirty-four; the third, aged thirteen, thirty; the fourth, eleven years, ten; and the fifth, two years old, two. All the fractures occurred in the femur, generally from very slight causes. The other children, all girls, strikingly resemble their father, and enjoy excellent health. Under proper treatment the fractures always unite very promptly, and, what is singular, none of these persons have, at any time, experienced any severe pain, so common under such circumstances.

There are, unfortunately, no reliable *symptoms* of this affection. On this account it is usually overlooked until it has reached its highest degree of development, when it is always incurable. In general, the person is laboring under severe pain, which, as it is usually regarded as of a gouty, rheumatic, or syphilitic character, is rarely, if ever, referred to its proper source, until after the occurrence of curvature, or fracture, from causes so slight as to awaken, for the first time, a suspicion of the real nature of the disease. As the disorder progresses, the appetite and strength become impaired, the suffering increases in violence, and the urine is surcharged with earthy constituents, especially phosphate and carbonate of lime. This alteration in the urine is observable at an early period, and in general fragility goes on gradually augmenting down to the time of death, which happens at from six to eighteen months, the patient meanwhile being perfectly bedridden.

There are then only two circumstances that can be at all relied upon as diagnostic of this complaint ; one is the severe and intractable character of the pain, deep-seated, and usually referred to the bones ; the other, the altered condition of the urine, as declared by the presence of an inordinate quantity of earthy matter, especially the phosphatic. When these phenomena coexist, there will be strong reason to conclude that there is serious lesion going on in the skeleton, and this suspicion will be converted into certainty when, superadded to them, there occurs, without any considerable external violence, curvature, fracture, or displacement of some of the bones.

Fragility, like softening, is generally an incurable affection. The only exception, perhaps, to this rule is when it occurs as an effect of the syphilitic or rheumatic poison, but even then it seldom admits of complete relief unless it presents itself in a very circumscribed form. The fragility of old age is always irremediable.

No rational *treatment* has yet been laid down for this disease, nor will it be possible to do so until we shall have more enlightened views of its etiology, pathology, and diagnosis. In all cases strict inquiry should be instituted into its origin, when such remedies should be administered as the result may seem to indicate. A tonic and supporting course, consisting of the different preparations of iron and quinine, and of the syrup of the phosphates, along with cod-liver oil, and vegetable acids, especially the citric, and a well-regulated, nutritious diet, will afford the best chance of relief in the scorbutic diathesis. Iodide of potassium and bichloride of mercury should be given in the syphilitic variety of the disorder; while in the gouty and rheumatic forms, colchicum may, probably, prove beneficial. In Dr. Battle's cases, above referred to, marked benefit has accrued from a change of vegetable to animal food. To relieve the excessive pain which is so prominent a symptom in the latter stages of the affection, especially when it involves a large portion of the skeleton, anodynes must be given in full and sustained doses. Curvatures and fractures must be treated upon general principles. In most cases union occurs very promptly; sometimes, however, it is very tedious, and now and then the parts refuse to heal, despite the best directed efforts of the surgeon.

SECT. XIII.—ATROPHY.

Atrophy of the osseous tissue is characterized by the partial absorption of its elementary constituents, as is evinced by its lightness and porosity. It may occur in any portion of the skeleton, but the long bones are oftener affected than the short or flat. Like hypertrophy, it may be partial or general; that is, it may involve an entire piece, or be limited to a particular part of it. Atrophy, moreover, may be concentric or eccentric. In the former variety the bone is diminished in its diameter; in the latter it retains its original size, but is reduced in weight, and rarefied in structure. The principal causes are, protracted pressure, chronic inflammation, deficient nervous influence, and insufficient supply of arterial blood.

α. The influence of steadily exerted *pressure*, in producing atrophy of the osseous tissue, is well exemplified in the cranial bones in tumors of the dura mater; in the sternum and dorsal vertebræ in aneurism of the aorta; and in the ribs in carcinoma of the mammary gland. In all these instances the compact substance is reduced to a thin, translucent plate, while the spongy texture is either wholly destroyed, or worn down to a few slender shreds. The immediate cause of the wasting process here is absorption, acting simultaneously and equally upon the animal and earthy constituents.

β. Atrophy from *chronic inflammation* is probably infrequent. One of the best specimens of it that I have ever seen occurred in a colored woman, who died of pulmonary phthisis at the age of forty. The body was much emaciated, and all the long bones were remarkably reduced in weight, although they had experienced no change in their external configuration. The compact substance was wasted to a mere shell, scarcely thicker than common wrapping paper, while the cells of the spongy texture were increased many times beyond the natural size. The medullary canal was much enlarged, and filled with a greasy reddish substance, not unlike fresh adipocire. These appearances are well shown in fig. 395, and afford a beautiful illustration of the eccentric form of atrophy.

Fig. 395.

Atrophy of Bone.

Atrophy is sometimes the result of local injury, as a blow, wound, or contusion. The wasting in this case may be limited to the site of the original mischief, or it may extend to the entire bone, which, however, is uncommon. In what manner such an injury operates, whether through the agency of inflammatory irritation or otherwise, in giving rise to atrophy, is unknown.

A bad form of atrophy, often followed by permanent lameness, occasionally occurs in the neck of the femur, as well as in other portions of the skeleton, from what is called interstitial absorption of the osseous tissue. It is generally caused by external injury, but may also arise from attacks of cold, gout, rheumatism, and syphilis. The
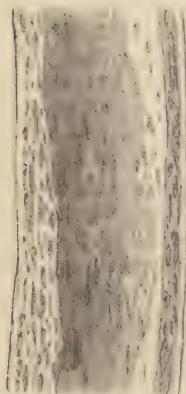
osseous structure wastes under its influence, and is frequently followed by important alterations in the conformation and direction of the affected bone.

γ. Deficient *nervous* influence is a frequent cause of atrophy both of the osseous tissue and of the soft parts. In paralysis of the lower extremities there is usually notable wasting, not only of the muscles, but also of the long bones, which are greatly reduced in weight, rarefied in their texture, and diminished in size. Atrophy of the osseous tissue is occasionally dependent upon general paralysis, especially if long continued.

δ. The effect of a diminished supply of *blood* in inducing atrophy of bone is sometimes very conspicuous in old fractures. In such injuries there is often considerable wasting of

Fig. 396.   Fig. 397.
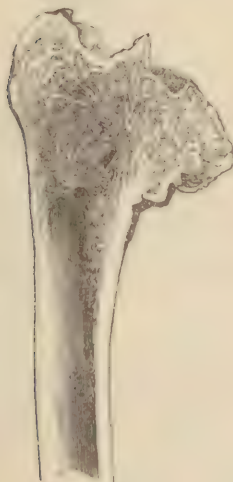
Atrophy of connective Structure
of the Thigh-bone.

Advanced stage of senile Atrophy
of the Thigh-bone.

the osseous tissue, simply from obliteration of the nutrient artery by the pressure of the callus. The atrophy is always eccentric, and is usually limited to one-third, one-half, or two-thirds of the affected bone, according to the seat of the original injury; or, more properly speaking, the quantity of the new matter, and the extent of the vascular obliteration.

ε. Finally, there is what is termed *senile atrophy*. In old age, the bones are rendered light, porous, and brittle; the compact substance is reduced to a mere parchment-like shell, while the areolar texture is remarkably rarefied or expanded; the muscular prominences are diminished in size; the animal matter is partially absorbed; and many of the vessels are obliterated. These changes are nowhere more conspicuous than in the neck of the femur, which, in consequence, often breaks from the most trifling causes, and which, after this occurrence, is seldom, if ever, repaired by osseous matter. Fig. 396 is a section of a well-marked specimen of this kind; the internal structure is very much rarefied; and the head of the bone, flattened and expanded, is approximated to the shaft, from the partial absorption of its neck. Fig. 397 exhibits the affection in a still more advanced stage with porcellanous deposits. Wasting of the alveolar process in edentulous subjects is a beautiful illustration of senile atrophy of bone unaccompanied by disease.

Atrophy of the osseous tissue does not admit of cure. All that the surgeon can do is to amend the general health, when that is at fault, and to remove any local causes of disease when they are found to exist.

SECT. XIV.—HYPERTROPHY.

Hypertrophy of the osseous tissue may be partial or general, as the abnormal growth affects either a portion or the whole of a bone. The latter, however, is very uncommon, except in some of the broad pieces of the skeleton, particularly those of the skull, which,

now and then, present an extraordinary degree of development, being, perhaps, three or four times the natural thickness, and so hard as to render it very difficult to saw them. The diploë is totally obliterated by dense, earthy matter. Similar appearances are sometimes witnessed in the cylindrical bones of the extremities. In an old femur in my private collection, the medullary canal is scarcely large enough to admit a common-sized quill; the whole shaft consists almost entirely of compact substance, in many places more

Fig. 398.

General Hypertrophy, showing the Internal Condition of the Bone.

than six lines in thickness. The bones of the male are always larger and more distinctly developed than those of the female, and the bones of persons who take much exercise than those who are indolent or inactive. By labor, their weight and dimensions increase; their spongy structure diminishes, whilst the compact becomes harder and more dense, and acquires an almost rock-like solidity; the muscular prominences are rendered more conspicuous; in short, everything indicates that they are in a state of general hypertrophy. The osseous tissue usually contains its due proportion of animal matter, and on this account does not readily yield under external injury.

Hypertrophy may affect a bone both in length and in thickness. The former occurrence, however, is only possible during the developmental period of bone, for as soon as the osseous tissue has attained its full growth it ceases. An increase in the thickness of a bone, on the contrary, may arise at any time from any cause capable of producing irritation and hyperemia.

Fig. 399.

Hypertrophy involving both the Thickness and Length of the Bone.

Sometimes the hyperostosis affects the entire skeleton, as in a case reported by Dr. J. Ewing Mears, in which the disease was associated with osteoporosis. The patient, a boy fourteen years of age, had died from exhaustion, after having long suffered, as was supposed, from strumous inflammation. The change of structure was most conspicuous in the bones of the extremities, those of the trunk and skull being but slightly affected.

The adjoining cut, fig. 398, from a specimen in my cabinet, is an excellent representation of general hypertrophy of the femur of a man affected with tertiary syphilis. The section of the bone exhibits its interior structure, which is very much condensed throughout, except at the superior extremity, where there are still some remains of the areolar tissue; the medullary canal is entirely obliterated, and the weight of the bone is nearly twice as great as in health. The exterior of the bone is very rough; and the periosteum was greatly thickened and indurated from chronic inflammation.

The annexed sketch, fig. 399, is a specimen of hypertrophy of the bones of the leg and foot, both in thickness and length. It is from a drawing of a preparation in the collection of the late Professor Buchanan, of Nashville. All the bones are much enlarged, increased in weight, and ankylosed at the ankle, tarsal, and metatarsal joints. The interosseous ligament was completely ossified. The foot and leg had been the seat of extensive ulceration, followed by exfoliation from the hypertrophied bones.

General hypertrophy of the bones is usually incurable. It is only, or chiefly, when it depends upon a syphilitic taint of the system that it admits of relief; but as this subject

has already been fully discussed elsewhere, it is not necessary to revert to it here.   Elongation is always irremediable.

SECT. XV.—OSTEOPHYTES.

An osteophyte is an osseous growth, differing from an exostosis in not forming a well-defined tumor, growing, as it does, upon rather than from bone.   It occurs chiefly in middle-aged and elderly subjects, upon the more vascular portion of bone, as its articular extremities, its rough lines, and its sutural cartilages, and is more frequent in the femur, fibula, and vertebræ than in any other pieces of the skeleton.

Fig. 400.

The ordinary osteophyte presents itself in a great variety of forms ; sometimes as a pointed stalactite, or sharp, thorn-like spicule, sometimes as a warty excrescence, sometimes as a lamella several lines in length and thickness, and some-times, again, as a body bearing a close resemblance to a coral. In the vertebræ, an osteophyte occasionally extends like a bridge from one piece to another, tying them firmly together ; and a similar arrangement now and then occurs between the articular extremities of some of the long bones, as between the femur and tibia.   The annexed cut, fig. 400, affords a good illustration of this disease as it sometimes occurs in the lower extremity of the femur.   The whole surface of the bone is roughened by the new growths.

The exciting causes of these osseous formations are not always appreciable.   In general, they are developed under the influence of a gouty, rheumatic, syphilitic, or scorbutic state of the system ; occasionally they are directly traceable to the effects of external injury, and cases occur in which

Osteophytes of the Inferior Extremity of the Femur.

they succeed to caries or necrosis.   Immense numbers of osteophytes are sometimes seen in osseous tumors, especially the fibrous and sarcomatous.   The immediate cause of the disease is inflammation, attended with a deposit of lymph, which is gradually converted into osseous tissue, similar to the callus of a broken bone.

There are no symptoms by which this disease can be recognized during life, unless the osteophytes are of great size or unusually prominent, when they may occasionally be distinguished by a careful digital examination.   Its progress is generally very tardy, and there is seldom any danger so long as these bodies do not exert any severe pressure upon important structures.

In the treatment of osteophytes, the first object should be to ascertain, if possible, the nature of the exciting cause, for upon a knowledge of this the whole management of the case will necessarily hinge.   A gouty, rheumatic, or syphilitic state of the system should be met in the usual manner.   The inflammatory character of the affection must not be overlooked.   Mercury is indicated in the earlier stages of the disorder.   The most suitable local remedies are tincture of iodine, iodide of lead ointment, leeches, and blisters.

SECT. XVI.—TUMORS.

The bones are liable to sarcoma, osteoma, chondroma, osteoid-chondroma, fibroma, myxoma, angioma, and hydatid cysts.   Primary carcinoma is not observed in the skeleton, although it is quite common as a secondary formation.   Cysts, with the exception of those which occur in the maxillæ in connection with the glandular follicles of the mucous membrane of the antrum, or with impacted and misplaced teeth, or with the periosteum of the fangs, are probably always due to mucoid softening and cystoid degeneration of myeloid, cartilaginous, and myxomatous neoplasms.   The only vascular tumor of the osseous system is aneurism by anastomosis or arterial erectile growth, true aneurism of the arteries of the bones being unknown, the pulsating tumors hitherto classed under that term being merely highly vascular sarcomas.

Neoplasms originate either from the surface or from the interior of the bones.   The superficial, peripheral, or periosteal growths, which are rather the more common, develop from the soft, osteogenic layer of the periosteum, the outer fibrous layer of the membrane constantly regenerating itself to form a limiting capsule for the tumor, as is shown in fig. 401, from S. W. Gross, which represents a peripheral round-celled sarcoma of the humerus.   The bone itself, between which and its investing membrane the mass is seated,
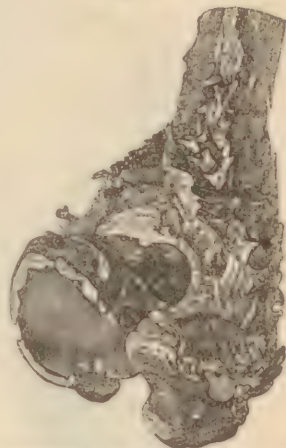
may be entirely normal, sclerosed, more or less absorbed and eroded, or fractured, or it may be the seat of new deposits in the medulla from the extension of the disease along the Haversian canals. The periosteal growths are moreover distinguished by their oval or fusiform outline, or by their pyriform shape, with the base towards the articulation, when they surround the articular extremities of the bones.

The central, endosteal, or myelogenic tumors start in the medulla and in the osteoblastic layer of cells which line the interior of the medullary canal, and they are also surrounded by a capsule which may be entirely bony, as in fig. 402, also from S. W. Gross, represent-

Fig. 401.   Fig. 402.

Periosteal Round-celled Sarcoma   Central Giant-celled Sarcoma of the Head of the Tibia.
of the Humerus.

ing a giant-celled sarcoma of the head of the tibia, but which is usually partly osseous and partly membranous. The bone, in which the neoplasm originates, finally disappears, and as the latter approaches the surface, it induces chronic ossifying periostitis, through which new layers of bone are constantly being produced to encapsule the growth in an osseous case. With the increase of the tissue of the tumor, the same changes occur in the newly formed shell as occurred in the original bone; but as it disappears, new osseous layers are simultaneously formed by the osteoblastic surface of the periosteum, and the deposit of new bone goes on step by step with the absorption of the older layers. In this way a more or less perfect bony capsule is formed around the central tumors, the minute processes concerned in its production being well shown in fig. 403, from Rindfleisch. The central tumors are generally spherical in shape, and, like the periosteal growths, their surface is generally smooth and even.

The majority of the neoplasms of the bones merely push aside and stretch the adjacent tissues; but sarcoma may become diffused and infect the surrounding textures. Fibroma, chondroma, and sarcoma are very liable to calcification and ossification; and sarcoma is frequently highly vascular and the seat of large effusions of blood. When a pulsating tumor is found in connection with a bone, it may be accepted to be a central sarcoma composed either of giant or of round cells.

Of the various degenerations of these growths, particularly the central myeloid and cartilaginous, the most common, as well as the most interesting, is the cystoid, through which cysts or cystoid spaces, both unilocular and multilocular, with fluid, semifluid, fatty, bloody, sanguinolent, or serous contents, are scattered throughout the mass, and sometimes

to so great an extent as to have replaced almost entirely the original structure, thereby giving rise to the term *cystic tumor* of the older writers. Sections of growths which have undergone this retrograde change convey the impression that the specimen is one of true cystic disease of the bones. The cavities are not, however, true cysts, but irregular spaces,

Fig. 403.
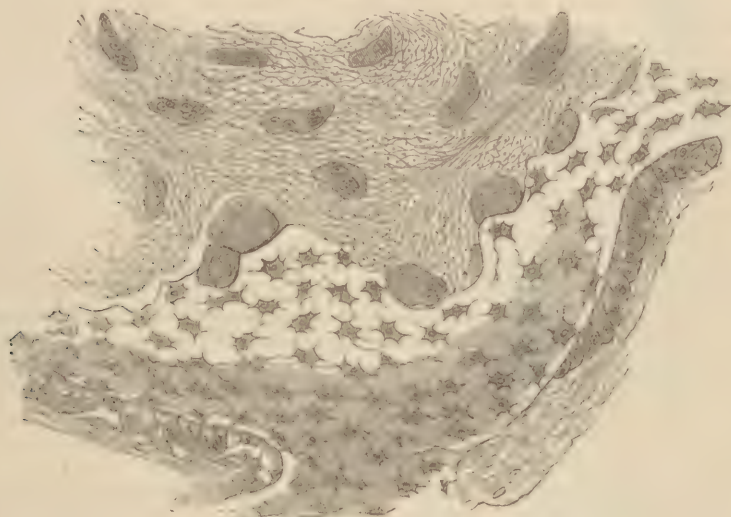
Formation of Bony Capsule in Central Tumors.

the walls of which are composed of fibrillated tissue studded with granular fat and drops of oil, or of the fibrous or osseous bands which intersected the original growth. Their origin is due either to liquefaction, or mucoid softening, of the cellular elements which have undergone fatty metamorphosis, or to extravasations of blood in the softened fatty areas from rupture of the enlarged and degenerated vessels. The contents, in the former event, are turbid, opaque, buff-colored, straw-colored, or clear, and, in the latter mode of formation, they consist of blood, coagula, or sanguinolent fluid. The consistence of the contents is variable; sometimes thin, sometimes glutinous, sometimes semisolid, and, finally, again, solid. The amount of fluid is occasionally so great as to give rise to enormous tumors, as in the examples of cystoid chondroma, recorded by Nélaton and Crampton, in which the thigh measured, respectively, six feet, and six feet and a quarter, in circumference.

Cystoid degeneration of neoplasms of the bones is of sufficient importance to give rise to a class of growths, which, as they differ materially from the solid tumors, are entitled to some consideration at this place in regard to their progress, prognosis, and symptoms. Such a division is incorrect from the standpoint of pathological histology, but it is convenient from a clinical point of view, and cannot well be ignored.

Cystic tumors of the bones are most common in young adults and middle-aged subjects; they are seldom met with before puberty, or after fifty; and they generally arise without any assignable cause, although sometimes their origin is directly traceable to the effects of external injury, as a blow, fall, or contusion. The progress of this disease is always slow. In the lower jaw serous cystic growths of six, twelve, and even fifteen years' standing often occur, without any serious disturbance of the general health, or any particular local disorder, save what results from the pressure of the tumor upon the surrounding structures. Neither the cysts, their contents, nor the parts adjacent manifest, as a rule, any tendency to malignancy; but when the tumor is large, it generally exhibits a marked tendency to destroy the bone in which it is located.

The symptoms of cystic disease of the osseous tissue are originally very vague. The first thing that usually attracts attention is a dull, aching pain in some particular bone, as, for example, the jaw, which is often mistaken for toothache, or rheumatism; this gradually increases in severity and frequency, and is at length found to be dependent upon the presence of a hard tumor, or the expansion of a portion of the bone, more or less tender on pressure and motion, but unattended by any discoloration or intumescence of the overlying

textures. The progress of the disease is always tardy, and it often happens that, after having attained considerable development, it remains, to all outward appearance, for some time perfectly stationary. Then, taking a new start, it again increases, and thus it continues, now advancing and now ceasing, until it has, perhaps, acquired the volume of a large orange, or even of a fist. Still, the general health continues good, there is no emaciation, and the countenance is perfectly free from that distressed, anxious, and sallow state which characterizes it in malignant disease. Even the pain is generally comparatively trivial, and if it were not for the mechanical obstruction occasioned by the encroachment of the tumor upon the adjacent parts, the patient would hardly be conscious of being unwell. If the parts be now carefully examined, they will be found to be of unequal consistence, the firmer being incompressible, while the softer ones readily yield under the finger, emitting a peculiar crackling noise not unlike that of dry parchment. When the investing capsule is entirely membranous, the consistence is soft and apparently fluctuating. In the absence of signs of malignancy, pulsation, lividity, and varicose enlargement of the overlying vessels, these circumstances afford the best evidence of the true nature of the disease; but if there is any doubt respecting it, this may generally be promptly dispelled by a resort to the exploring needle, the want of resistance and the escape of serous or sero-sanguinolent fluid determining the diagnosis. The tardy growth of the tumor and the absence of constitutional disorder are, indeed, commonly of themselves sufficient to mark the character of the malady. Between cystic and hydatid affections of the bones no signs of distinction exist, nor is this a matter of importance, as the treatment is essentially similar.

1. SARCOMA.

By far the most important of the tumors of the osseous system, as it constitutes nearly one-half of the neoplasms of the maxillæ, and affects the long bones almost as frequently as all the other morbid growths combined, is sarcoma, which up to comparatively a recent period was described under a great number of different and confusing names. In an elaborate paper on sarcoma of the long bones, published by Dr. S. W. Gross in the American Journal of the Medical Sciences for July and October, 1879, the entire subject has been so exhaustively investigated that its contents have been freely utilized in the following description. The consideration of the disease, as it involves other pieces of the skeleton, will be found in the second volume of this work in its appropriate places.

Sarcomas of the long bones evince a great predilection for their articular extremities, in the spongy substance of which the majority are developed. Whether of central or peripheral origin, their favorite seats are the femur, tibia, humerus, fibula, ulna, and radius. In accordance with their point of departure and histological construction, they may be classified, in the order of their frequency, as central giant-celled, periosteal osteoid, central spindle-celled, periosteal round-celled, central round-celled, and periosteal spindle-celled, the first two varieties constituting nearly 70 per cent. of the entire number. Males are more liable to their occurrence by 17 per cent. than females. The age at which they first appear averages twenty-seven years, 68 per cent. occurring before the thirtieth year, and 32 per cent. after that period, the disease being comparatively uncommon after the age of forty. The period of life at which they manifest themselves appears to be influenced by their seat and structure, the average being twenty-two years for the periosteal osteoid, twenty-three for the periosteal round-celled, twenty-four for the periosteal spindle-celled, twenty-eight for the central round-celled, a fraction above twenty-eight for the giant-celled, and thirty-six for the central spindle-celled. In about one-half of all cases they may be traced to injuries, such as blows, falls, sprains, fractures, and kicks.

With the exception of carcinoma of the soft parts, sarcoma of the bones is the most malignant of all neoplasms; but the lymphatic glands are, as a rule, free from contamination, thereby showing that systemic infection takes place through the blood and not through the lymph channels. Metastatic tumors were discovered, especially in the lungs, lymphatic glands, and other parts of the osseous system, in 46 per cent. of the 165 cases analyzed by Dr. Gross, and they were histologically identical with the primary growth. In the order of their malignity, the sarcomas may be classed as periosteal spindle-celled, periosteal round-celled, periosteal osteoid, central round-celled, central spindle-celled, and central giant-celled, the periosteal tumors being more malignant than the central by 43.5 per cent.

Sarcoma not only evinces a decided tendency to infect the surrounding tissues, but in one example out of every seven and one-third it projects masses into the adjacent joint, as

is represented in fig. 404, from a preparation in my collection, and may even extend along the intraärticular ligaments into the apposed bone. In the majority of these cases, however, the cartilage of incrustation remains intact, and affords a delicate investment for the growth. Invasion of the joints is met with in 18 per cent. of the central and in 7 per cent. of the periosteal tumors; and the possibility of its occurrence should not be lost sight of in selecting the point at which an amputation should be performed for the relief of the disease.

In the absence of minute examination, a pretty accurate idea of the structural nature of these tumors may be formed from their gross appearances. Thus as dark-red or maroon color suggests a giant-celled sarcoma; a firm, glistening, grayish-white tissue is characteristic of fibrous or large spindle-celled growths; and a tint and consistence similar to that of the fœtal brain indicate a round-celled or small spindle-celled tumor, to which the term medullary or encephaloid is applicable, and the assumption will be greatly strengthened if the tissue resembles a recent coagulum, or is interspersed with cavities filled with blood. An admixture of osseous or calcareous masses with soft tissue warrants the diagnosis of an osteoid sarcoma, the nature of the softer portions determining the variety of sarcoma to which the specimen belongs.

The differential diagnosis of these varieties of sarcoma may usually be determined by attention to their affinities and contrasts, which are set forth in the following tables :—

Fig. 404.

Periosteal Spindle-celled Sarcoma, invading the Knee-joint.

Clinical Features of Central Sarcomas.

	Giant-celled.	Spindle-celled.	Round-celled.
Frequency of occurrence	71.42 per cent.	16.32 per cent.	12.24 per cent.
Appear before the 30th year	66.66 "	37.5 "	58.33 "
Seated in the shaft of the long bones	5.71 "	27.27 "	33.33 "
Ushered in by pain	50 "	60 "	75 "
" " swelling	19 "	30 "	25 "
" " " and pain	31 "	10 "	0 "
Pain throughout the disease	40 "	100 "	91 "
Skin variously altered	33 "	40 "	41 "
Subcutaneous veins enlarged	27 "	50 "	41 "
Infection of adjacent tissues	12 "	18 "	66 "
Lymphatic glands tumified or involved	16 "	0 "	25 "
Metastatic deposits	22.72 "	23.07 "	33.33 "
Local recurrence	8 "	20 "	25 "
Pulsation	20 "	12.5 "	33.33 "
Joints invaded	14 "	25 "	25 "
Fracture, spontaneous, or from slight causes	4 "	44 "	50 "

Clinical Features of Periosteal Sarcomas.

	Round-celled.	Spindle-celled.	Osteoid.
Relative frequency	1.40 per cent.	13.43 per cent.	67.16 per cent.
Occur before 30th year	63.63 "	66.66 "	91.66 "
Seated around shaft of the long bones	89 "	55 "	39 "
Ushered in by pain	55 "	85.71 "	62 "
" " swelling	44 "	14.29 "	33 "
" " " and pain	0 "	0 "	4 "
Pain throughout the disease	66 "	100 "	98 "
Skin variously altered	50 "	22.22 "	20 "
Subcutaneous veins enlarged	41 "	33.33 "	31 "
Infection of adjacent tissues	50 "	44 "	40 "
Lymphatic glands tumified or involved	38.46 "	11 "	21 "
Metastatic deposits	66.66 "	100 "	65.62 "
Local recurrence	50 "	60 "	41 "
Pulsation	0 "	0 "	3 "
Joints invaded	15.38 "	0 "	6 "
Fracture, spontaneous, or from slight causes	7 "	11 "	3 "

It will thus be observed that giant-celled tumors, which are the least malignant, occur at an earlier age, and are marked by sympathetic lymphatic involvement, nearly two-thirds as frequently as the round-celled, which are the most pernicious of the central tumors. It is also notable that the lymphatic glands are never enlarged in the central spindle-celled sarcomas, and as this statement is almost true of the same variety developed from the periosteum, it forms an important point in the diagnosis. It will, moreover, be seen that a central tumor occupying the shaft of a bone is far more likely to be round-celled or spindle-celled than giant-celled. Spontaneous fracture and invasion of the joints is far more common in the central than in the periosteal tumors, and are quite characteristic of medullary growths. Enlargement of the subcutaneous veins and alterations of the integument are also more frequent in the central than in the peripheral sarcomas, although the latter occur at an earlier age. Of the various symptoms, one of the most interesting is pulsation, which is observed in one case out of every eight, and which has led certain writers to describe these tumors as aneurisms. It is not met with in any other neoplasm of the bones, and is, therefore, when present, of great diagnostic value. With one exception it has only occurred in the central tumors, and is more common in the round-celled than in the other varieties. A curious fact in regard to pulsation, and it is one that is useful in the discrimination between the sarcomas, is that the chances are three to one that a pulsating sarcoma of the shaft of a long bone is composed of round-cells, and that in no instance is it a myeloid sarcoma: whereas, if the pulsating growth occupies the epiphysis, the chances are ten to one that it belongs to the giant-celled variety.

The only one of the neoplasms of the tubular bones that is liable to occasion errors in diagnosis is chondroma. When compared with central sarcoma, central chondroma is of infrequent occurrence; it is less painful, of slower growth, of firmer consistence, and has a bosselated outline, which is rarely seen in sarcoma unless the capsule is perforated. It is more common in males; never occurs so early or so late in life as sarcoma; does not pulsate, invade the joints, fungate, or give rise to metastatic deposits. Central chondroma, however, in consequence of the cystoid degeneration to which it is so liable, attains a larger volume than sarcoma, and is accompanied in the majority of cases by enlargement of the subcutaneous veins. Periosteal chondroma is relatively more common than periosteal sarcoma. It is far less painful, of slower growth, of denser consistence, and of a nodular outline. It is usually met with in females; does not occur so early in life, and is observed at a more advanced age than sarcoma. The subcutaneous veins are not so liable to enlargement; the integuments evince little disposition to inflame or ulcerate; the tumor does not pulsate, fungate, or invade the joints, or contaminate the glands; and it occasions secondary deposits only one-twentieth as often. In one-third of all cases other portions of the skeleton are simultaneously affected; while multiple growths are only witnessed in sarcoma as the result of infection.

Sarcoma is liable to be confounded with other affections, of which strumous articular osteitis is the most common. White swelling of the knee, for example, usually occurs in scrofulous subjects before the age of fifteen. The pain, which is experienced from the very outset, finally becomes very severe; the skin is tense and glossy; the superficial veins are abnormally prominent; the temperature is elevated; the joint is stiff, resents efforts at motion, and is, moreover, distorted and flexed; puncture gives vent to turbid synovial or purulent fluid; and the swelling does not pulsate, nor does it impart a parchment like crepitation on manipulation. In sarcoma, the movements of the joint are preserved, there is no suffering on motion, and the limb is not fixed in a vicious position. In this affection there is no tendency to the formation of pus; the tumor not infrequently pulsates and affords crepitation on palpation; and spontaneous fracture is not uncommon. White swelling yields to rest, extension, and gentle and equable compression; but sarcoma continues to grow under the employment of these measures, and compression occasions not a little local suffering. The latter affection is not met with at so early an age as white swelling, and it occurs in persons of excellent general health.

The principal features of the sarcomas as a class having thus been considered, the general pathology and diagnosis of the individual tumors demand attention.

1. *Giant-celled Sarcoma.*—Myeloid or giant-celled sarcoma, which invariably occurs as a central growth, and of which a beautiful illustration is afforded by fig. 402, constitutes 42 per cent. of all the sarcomas of the long bones, and has a predilection for the epiphyses of the tibia, femur, and fibula, the shafts being involved in only one example out of every fourteen. It is most common between twenty-one and forty years; increases more slowly than the other sarcomas; is free from pain and tenderness; the skin almost always preserves its mobility and natural tint; the subcutaneous veins are rarely

enlarged; the surrounding tissues are not implicated by extension of the disease; the lymphatic glands are never involved except in 16 per cent. of all cases, and then only as the result of irritation; the joints are invaded in 16 per cent. of all examples; the spherical tumor pulsates in one example out of every five; and the affected bone is rarely broken. The prognosis is comparatively favorable, metastatic tumors developing in only about 23 per cent. of all examples, and local recurrence after amputation or resection being witnessed in one case out of every twelve and a half. In connection with the general dissemination of the disease it is interesting to note that the tumor had undergone calcareous or osseous degeneration, through which it resembled the periosteal osteoid growths, in four-fifths of the cases; while of the cases in which these changes were not present, only one out of fifteen was characterized by secondary growths.

2. *Central Spindle-celled Sarcoma.*—Central spindle-celled sarcoma, which includes many examples of the encephaloid tumors of the older writers, is next to the preceding variety the most common of the myelogenic growths. Rather more than one-fourth of all cases originate in the medulla of the shaft of the long bones, and they appear less frequently in early adult life than myeloid tumors. Its growth is slow, and attended with suffering; the skin is discolored or adherent in 40 per cent., and the veins are enlarged in one-half of all cases. Spontaneous fracture, or fracture from trifling causes, of the affected bone is observed in 44 per cent. of all examples, and is a sign of great diagnostic value. Pulsation and other signs of aneurism are met with in one case out of every eight. The lymphatic glands are never involved; but metastatic tumors form in 23 per cent. of all cases; and local recurrence is observed in one example out of every five, the malignity being, therefore, slightly greater than that of myeloid sarcoma.

3. *Central Round-celled Sarcoma.*—Myelogenic round-celled sarcoma, which includes the alveolar variety of the disease, and which always constitutes medullary tumors, is the least common of the central growths, but forms in the shafts of the tubular bones in the proportion of 33.33 per cent. It occurs, on an average, earlier in life than spindle-celled sarcoma, but at about the same period as giant-celled. Its development is very rapid and is marked by suffering, changes in the skin, enlargement of the veins, infection of the adjacent tissues, invasion of the joints, and fracture of the bone in which it originates. Pulsation is observed in one-third of all examples, and hence a pulsatile growth of the shaft of a long bone may very properly be referred to this variety. The lymphatic glands are enlarged in one-fourth of all cases; metastatic deposits occur in one-third; and repullulation after removal in one-fourth; thus showing that round-celled tumors are the most malignant of the endosteal sarcomas.

4. *Periosteal Spindle-celled Sarcoma.*—Peripheral spindle-celled sarcoma surrounds the epiphyses more frequently than the shafts of the long bones, and is a disease of early adult life. Its growth is relatively slow, and invariably accompanied with suffering; the skin is variously altered in 22 per cent., and the subcutaneous veins are prominent in 33 per cent. of all cases; the lymphatic glands are enlarged, and spontaneous fracture occurs in 11 per cent.; it does not pulsate, nor does it invade the joints; but the adjacent tissues are infected in nearly one-half of all cases. It is the most malignant of all the sarcomas, recurring in six-tenths of all cases after amputation, and invariably giving rise to metastatic deposits.

5. *Periosteal Round-celled Sarcoma.*—Periosseous round-celled tumors are developed around the shaft nearly twice as often as around the articular extremities of the bones. Like the preceding variety it is most common before the thirtieth year. Its increase is very rapid, and usually painful; the skin is adherent, discolored, or ulcerated in 51 per cent. of all instances; the veins are enlarged in 41 per cent.; the lymphatic glands are tumefied in 38 per cent.; spontaneous fracture occurs in 7 per cent.; and the temperature is elevated in 33 per cent. of all cases. The tumor never pulsates; but it invades the surrounding soft tissues in 50 per cent., and the joints in 15 per cent. of all examples. Local recurrence after operation is observed in one-half of all cases, and metastatic tumors are developed in two-thirds of all examples.

6. *Periosteal Osteoid Sarcoma.*—From the remarkable tendency evinced by the peripheral sarcomas, especially the spindle-celled variety, to undergo calcareous infiltration, or osseous transformation, a variety has arisen which is imperfectly understood, as it is generally described as osteoid cancer. In the most characteristic specimens of the disease the osseous or cretified material radiates from the surface of the affected bone to the circumference of the growth, in the form of long, delicate, fragile spicules, tufts, or plates, which are closely aggregated at their bases, and pursue a parallel course perpendicular to the surface of the bone, or diverge towards the circumference, as in fig. 405, from a sketch

sent me by the late Professor Buchanan, of Nashville. These tumors constitute 27 per cent. of all the sarcomas of the long bones, and 67 per cent. of the periosteal growths; and they develop, as a rule, around the epiphyses of the femur and the tibia. The average age of their appearance is twenty-two years. During their rapid growth the suffering becomes intense; the skin is altered in one instance out of every five; the veins are enlarged in less than one-third of all cases; the adjacent tissues are infected in 40 per

Fig. 405.
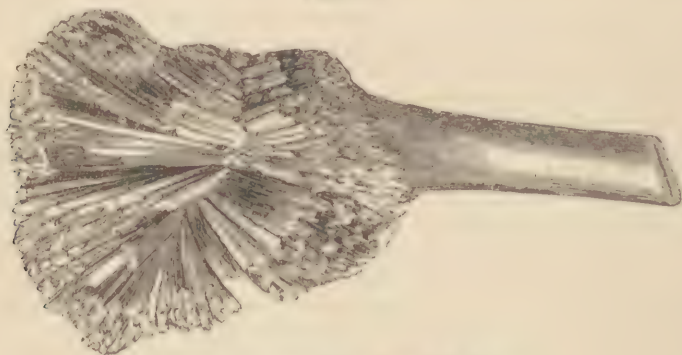
Osteoid Sarcoma of the Head of the Tibia.

cent. of all examples, but the joints are rarely invaded; and pulsation and spontaneous fracture are rarely observed. The lymphatic glands are swollen in 21 per cent. of all cases, and in one-half of these they are converted into bony tissue; secondary growths are met with in 65 per cent. of all cases; and the disease recurs locally after amputation in two-fifths of all examples. Hence, they are, next to the periosteal spindle-celled and round-celled, the most malignant of the sarcomas.

Treatment.—If left to itself, sarcoma inevitably proves fatal, whereas timely operations not only prolong life, but not infrequently eventuate in permanent recovery in all the varieties except the periosteal spindle-celled. In regard to the choice of the procedure, as to whether this should be amputation or excision, the decision must be given in favor of the former, the removal being effected as high up, or as near to the trunk as possible, for the reason that the joints are liable to be invaded by the disease, and that nodules of sarcomatous tissue may exist in the medullary canal at some distance above the original growth. In giant-celled tumors Dr. S. W. Gross has framed, in what I entirely concur with him, the following general rules for guidance in selecting the point at which amputation should be performed. For tumors of the lower epiphyses of the tibia and fibula, just below the knee; when the upper articular extremities of these bones are involved, through the lower part of the thigh; at the junction of the upper and middle thirds of the thigh for disease of the condyles; at the hip-joint for that of other portions of the femur; below the elbow for tumors of the lower epiphyses of the radius and ulna; through the lower third of the arm when the upper epiphysis of the ulna is affected; at the junction of the upper and middle thirds of the arm, for disease of the condyles of the humerus; and at the shoulder-joint when the head of the humerus is involved. When the growth is very bulky the incision may have to be made higher up. Thus, a sarcoma, as large as the head, commencing in the lower extremity of the radius, had best be removed by disarticulation at the elbow. In all of the other varieties of sarcoma, the rule should be to amputate as far as possible from the seat of the disease as may be consistent with the safety of the patient. Of nine cases of excision of the affected bone for giant-celled sarcoma, death ensued in four, either as the result of the operation or of recurrence of the disease, and moderately useful limbs were obtained in two. In deciding upon the propriety of an operation, enlargement of the lymphatic glands should not be regarded as a bar to interference, since their tumefaction was due to irritative hyperplasia in more than two-thirds of the cases in which their condition was determined.

2. OSTEOMA OR EXOSTOSIS.

An exostosis, of which fig. 406 affords a good idea, is an osseous outgrowth, the word, which is a Greek compound, signifying a bone growing from a bone. It is, in fact, a local

hypertrophy, a circumscribed tumor, possessing essentially the same structure as the bone from which it springs, and with the substance of which it is usually intimately identified.

The disease occurs chiefly in young and middle-aged subjects, being very infrequent before puberty, and after the fiftieth year. It is more common in males than in females, and is generally confined to particular bones, as those of the cranium and extremities, especially the femur, and the phalanx of the great toe. The superior maxillary sinus is

Fig. 406.

Exostosis of the Thigh-bone.

occasionally the seat of exostoses, as in a specimen in my collection, in which the inner surface of the left antrum is literally studded with these growths, none of which exceed a small grain of wheat, which they also much resemble in shape. A bony tumor in this locality sometimes acquires an enormous bulk, and, when both cavities are affected simultaneously, may occasion great deformity.

In the flat bones, as those of the head and pelvis, the outgrowth may occur upon either surface; in general, however, it evinces a preference for the external one, probably because it has a more perfect periosteum. When the tumor is attached to the inner surface, constituting what is known as an *enostosis*, its tendency is to encroach more or less seriously upon the contents of the cavity which the bone assists in forming. Enostosis is most common in the cranium of syphilitic subjects.

A tendency to exostosis is sometimes observed in several members of the same family, as in the case of a lady who was under my charge on account of a tumor of this kind on the shaft of the left radius, and whose sister and brother each had a similar enlargement, the former on the occipital bone, the latter on the clavicle. Boyer has recorded the particulars of a case in which the disease was hereditary, the patient's father, brothers, sisters, nephews, and children having all suffered in a similar manner.

The number of these outgrowths varies from one to a great many. Cases occur in which there is a kind of exostosic diathesis. Thus, in the Mütter collection there is the skeleton of a female in which nearly all the bones are thus affected.

Exostoses sometimes observe a symmetrical arrangement, tumors of the same size and shape occurring at the same points of the corresponding pieces of the two sides. Such a disposition is occasionally witnessed on the frontal bone and the lower jaw, but is most common on the humerus and femur, especially at their inferior extremities.

The volume of these growths is subject to no little diversity, some being very small, while others are extremely large—equal, perhaps, to the size of an adult head. The most bulky usually occur upon the bones of the extremities, particularly the lower part of the femur, although they are also occasionally seen upon the cranial, facial, and pelvic bones, where their presence may be a source of the most hideous deformity.

Their shape is also very variable; sometimes they have a distinct, well-defined outline, being of a globular, ovoidal, or hemispherical figure; occasionally they jut out like long, slender spines or stalactites; in another series of cases, they have a knobby, nodulated, tubercular, or mammillated appearance; and, lastly, instances occur in which they assume the form of plates or lamellæ. These varieties of shape are doubtless entirely due to accidental circumstances; but they nevertheless deserve attention, on account of their practical relations. In regard to their surface, this may be either perfectly smooth, scabrous, or spiculated; most generally the latter.

The adjoining sketch, fig. 407, represents a remarkable form of exostosis, from a drawing of a specimen kindly presented to me by Dr. Lewis, of Alexandria. It grew upon the right femur of a lady, fifty-one years old, having commenced when she was only nine years of age. The tumor, before removal, was about the volume of a cocoanut, oval, smooth, and very hard. The integument over its summit had latterly become inflamed and ulcerated, followed by a discharge of sanious matter, and the protrusion of a portion of bone. The general health becoming somewhat impaired, amputation was performed

Exostosis of the Femur.

at the lower third of the thigh, the woman making an excellent recovery. This case is additionally interesting from the circumstance that several of the relatives of the patient had been affected with similar tumors.

As to their origin, there is no doubt that, in the great majority of instances, exostoses arise without any assignable cause. On the other hand, they may often be traced directly to the effects of injury, as a blow or kick. In the distal phalanx of the great toe, a not uncommon seat of the disease, it is not unlikely that the pressure of the boot is able to produce it. Exostosis in the stump after amputation of the thigh and leg is probably due to the jarring which the femur and tibia experience during the operation of sawing, aggravated, perhaps, by a partial laceration of the periosteum. Numerous exostoses are sometimes developed under the influence of a syphilitic, gouty, or rheumatic state of the system.

The immediate cause of exostosis is formative inflammation, the process of development being precisely similar to that which governs the formation of normal bone. The concomitant inflammation is not always seated exclusively in the bone, but partly in the bone and partly in the periosteum; and cases occur in which there is reason to believe that the latter is mainly involved in the production of the tumor.

In regard to its structure, an exostosis differs in no wise from that of healthy bone. It is essentially composed of two parts, a compact and an areolar, the former inclosing the latter as a dense, firm layer, varying in thickness from the sixth of a line to a quarter of an inch, according to the volume of the tumor. The compact substance sometimes constitutes the greater bulk of the morbid mass, and there are cases, especially when it involves the cranium, where it is of the consistence of ivory, being so close and hard as to render it extremely difficult to saw it. Such a structure is represented in fig. 408, from a specimen in my collection. The areolar texture is sometimes directly continuous with that of the bone from which the exostosis grows; at other times, however, it is independent

Fig. 408.

Ivory-like Exostosis, showing its internal Structure.

of it, as in fig. 409, being either in immediate contact with the compact structure, or separated from it by a stratum of cartilage, or fibrous tissue. Its cells are of variable size and form, and are generally loaded with fatty matter, very much as in a short bone of the skeleton, or in the articular extremity of a long one.

The identity of the structure of exostosis with that of natural

Fig. 409.
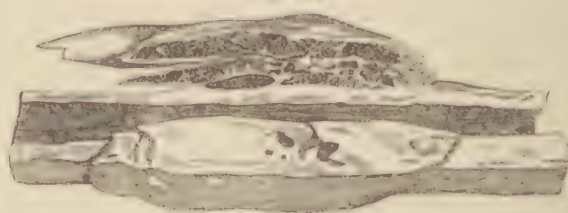
Spongy Exostosis of the Femur, with a broad Base and pointed Processes.

bone is proved, moreover, by chemical analysis. Even when the new substance is of unusual firmness, as in the eburnized variety of exostosis, the difference is much less than might, at first sight, be imagined. The following comparative analysis of healthy bone and of an ivory exostosis, by Berzelius, places the subject in a clear light. The principal difference, it will be observed, consists in the presence, in the latter, of an unusual quantity of phosphate of lime, and in a marked diminution of carbonate of lime and salts.

	Healthy Bone.	Eburnized Exostosis.
Animal matter	33.30	28.57
Phosphate of lime and magnesium	54.20	68.88
Carbonate of lime and salts	12.50	2.00
Loss	00.00	00.55
	100.00	100.00

An enostosis is precisely of the same structure as an exostosis. The distinction, in fact, has reference merely to the situation of the tumor, the one, as the name implies, being developed upon the inner, and the other upon the outer, surface of the bone.

When an exostosis is seated in a part of the body which is habitually the subject of considerable motion, as, for example, the inferior portion of the femur, it is usually surrounded by a distinct capsule, a sort of synovial burse, designed evidently to ward off friction and facilitate gliding. The inner surface of the capsule, which is of variable thickness, is perfectly smooth, unadherent, and lubricated by a sero-oleaginous fluid, so as to qualify it the better for the performance of its functions. Where no motion is required, the growth lies in immediate contact with the natural structures, the union between them being commonly so intimate as to demand a careful use of the knife to effect their separation. Occasionally, indeed, the soft parts are partially imprisoned in the osseous tumor, thereby rendering the dissection peculiarly tedious and difficult.

The progress of this disease is generally tardy; it is only now and then that a case pursues a different course, or where the symptoms partake of an acute character. A syphilitic exostosis occasionally attains a considerable bulk in a short time, and a similar occurrence has been observed, although less frequently, in the rheumatic form of the complaint. Under such circumstances, the formation of the tumor is generally attended with severe pain, liable to nocturnal exacerbations, tenderness and swelling of the part, and more or less constitutional disturbance. Ordinarily, however, there is nothing of the kind; the disease comes on slowly and almost imperceptibly, the first thing that arrests attention being a small tumor, which is altogether insensible, and exceedingly tardy in its progress, years elapsing before it acquires the size, perhaps, of a pullet's egg. If it be superficial, so as to admit of examination, it will be found to be hard and immovable from the first, and so it generally continues ever afterwards, whatever may be its bulk. Meanwhile, although it may itself be entirely indolent, it may be productive of pain in the surrounding structures, by the compression which it exerts upon the nerves, and in this way the suffering is sometimes rendered exceedingly severe, being often of a neuralgic character, darting about in different directions, and extending far beyond the seat of the bony growth. When the tumor is situated among parts that are much exposed to motion, it frets and irritates them, and thus greatly aggravates the local distress. As the morbid mass enlarges, it must necessarily act obstructingly, interfering with the functions of the affected structures, and ultimately, perhaps, entirely abolishing them. Thus an exostosis of the orbit may continue to increase until it pushes the eye completely out of its socket, not only filling the whole cavity, but encroaching more or less extensively upon the cheek and cranium. In a similar manner an osseous tumor may project into the pelvis, and impede the delivery of the child. Boyer refers to a case in which a growth of this kind, attached to the pubic bone, pressed against the neck of the bladder, and caused retention of urine, for the relief of which it was impossible to introduce the catheter. An exostosis of a rib may compress the lungs; of a vertebra, the spinal cord; of the cranium, the brain. Another effect is that it stretches, flattens, and displaces the muscles, tendons, nerves, and vessels, thereby partially disqualifying them for the exercise of their functions. Sir Astley Cooper has recorded an instance of gangrene of the arm from compression of the axillary artery by an exostosis of the lower cervical vertebræ.

Sometimes the coverings of the tumor are invaded by ulceration and even gangrene, thereby more or less freely exposing its surface, which occasionally, in turn, takes on the same kind of action. At other times the morbid mass perishes, apparently from a want of nourishment, and is detached very much in the same manner as a slough of the soft parts. Exostoses of immense volume occasionally experience such a fate. The occurrence is most likely to happen when the tumor has a narrow, cartilaginous base.

The *diagnosis* of exostosis cannot always be easily determined unless the tumor is situated superficially, when its great firmness and immobility generally serve to point out its true character. When the tumor occupies some internal cavity its nature may be suspected, but no surgeon, however skilled in diagnosis, can positively say to what class

of growths it belongs. On the other hand, an exostosis may sometimes seriously interfere with the diagnosis of other affections. Thus, a tumor of this kind, occupying the pelvic cavity, may impinge against the bladder, or even project into it, in such a manner as that the sound, coming in contact with its surface, shall impart a noise and sensation similar to those communicated by the presence of a calculus.

An exostosis, lying immediately beneath an artery, may simulate an aneurism, as in a case mentioned by Stanley. A patient was admitted into the Middlesex Hospital with a tumor presenting all the symptoms of aneurism of the subclavian artery. The pulsation in front of the swelling was very strong, and extended over a large space; but none could be detected at the sides. The axillary artery beat feebly, and no motion whatever existed in the vessels of the arm. A careful examination discovered an exostosis of the first rib, pushing the subclavian artery forwards, and flattening it.

The *prognosis* varies. So long as the tumor is small and indolent, it may commonly be considered as of little moment; but when it increases rapidly, or is so situated as to interfere with the functions of a joint, or to encroach upon an important organ, it becomes a matter of serious import; the more so, because it is then not always possible to get rid of it by an operation, and there is generally nothing else that can reach it. When an exostosis projects into a joint, an operation is a hazardous undertaking, liable to be followed by the worst results; and when it occupies an internal cavity it is generally utterly inaccessible. An exostosis of the inner surface of the cranium usually proves dangerous by determining epilepsy, paralysis, and other bad symptoms; in the pelvis it may, as already stated, interfere with parturition, and in almost any part of the body it may induce neuralgia.

Treatment.—The treatment of exostosis must be guided, in great degree, at least in its earlier stages, by the nature of the exciting cause. When the affection has been occasioned by a deranged state of the system, or by the rheumatic, gouty, or syphilitic poison, colchicum, aconite, and iodide of potassium, either alone, or in union with bichloride of mercury, will be indicated, and can hardly fail, if judiciously administered, to prove highly beneficial. Under the influence of these remedies growth is often promptly arrested, and the tumor eventually entirely dispersed. The use of mercury is particularly serviceable in these cases, but to produce its full effects it is generally necessary to carry it to the extent of gentle ptyalism, maintained for some time, especially in obstinate cases. When the complaint gives rise to much pain, opium, conjoined with diaphoretics, will be required.

Topical applications are particularly useful when the tumor is of rapid growth, exquisitely sensitive, and the result of external injury, or of a syphilitic taint of the system. In the earlier stages of the disease, the remedies most to be relied upon are leeches, blisters, saturnine lotions, and tincture of iodine employed in the ordinary way. If blisters, which are the most valuable of all topical means, are used, the skin over the tumor should be raised very thoroughly, a free discharge being afterwards maintained by some stimulating unguent, with a view to a permanent pyogenic effect. In the syphilitic form of exostosis, mercurial fumigations sometimes answer a good purpose, succeeding when all other remedies fail.

When the tumor has attained considerable bulk, and, above all, when it is of long standing, and of great firmness, or productive of excessive suffering, the only chance of relief is ablation; or, if this be impracticable on account of the nature and extent of the exostosis, amputation of the affected limb. The incisions through the integument are made as in ordinary growths, the most eligible shape being the crucial, elliptical, curvilinear, or T-like. Free exposure is effected, without interfering with any important structures, the division of which might afterwards impair the usefulness of the parts. If the skin is diseased, or much attenuated, the affected portion is, of course, removed. The exostosis is then attacked with the knife and a metacarpal saw, the former alone, if stout, being commonly sufficient to effect ablation when the tumor has a cartilaginous base, or an unusually soft structure. In general, however, the saw will be necessary, and there are many cases where the gouge, chisel, and trephine may advantageously be employed. If the tumor has a very large base, and is insensibly blended with the substance of the bone from which it grows, it should be divided into several sections, by perforating it at different points, and then detaching them separately, or piecemeal. Various kinds of saws have been invented for removing exostoses, but they are all more or less complicated and unwieldy, and may well be replaced by the more simple instruments in common use. The surgical engine has lately been called to the surgeon's aid in the removal of exostoses, and promises to supersede most, if not all, other instruments hitherto used in these ope-

rations. In whatever manner the ablation is effected, the bony portion of the wound should be rendered as smooth as possible by means of the raspatory, otherwise it will seriously interfere with cicatrization. As it is, there will, in any event, be more or less suppuration, retarding the progress of the cure, and the patient may congratulate himself if he escapes erysipelas and other bad consequences. The hemorrhage attending the operation is usually very slight. The edges of the wound should be lightly approximated, and the parts kept constantly wet with saturnine and anodyne lotions, either cold, cool, or tepid, according to the exigencies of the case.

3. CHONDROMA.

The cartilaginous tumor may be developed in the cancellated structure or upon the outer surface of the bones, beneath the periosteum, the latter mode of origin being the more common. Its figure is globular; its surface rough, or nodulated; its consistence firm, dense, and elastic; its color white, or grayish. The morbid mass may attain a large bulk. When it originates in the central part of the bone its capsule persists longer than in other central osseous tumors; but it finally becomes attenuated and gives way at one or more points, and thus allows the morbid growth to protrude beneath the surrounding soft tissues.

This tumor ordinarily affects only one bone, is not, as a rule, malignant, and is productive of little inconvenience, except from its size and weight. It is peculiar to early life, is often directly chargeable to external violence, manifests, when of long standing, a tendency to undergo certain degenerations, especially the calcareous, mucous, and cystic, is generally slow in its progress, and occasionally appears simultaneously in several parts of the skeleton. Every portion of the osseous system is liable to it; but the pieces most frequently affected are the metacarpal bones, the phalanges of the fingers, the humerus, and the lower jaw. In old cases the growth sometimes undergoes partial ossification, as in the specimen represented in fig. 411. Fig. 412 exhibits a cartilaginous tumor of the ribs, from a drawing of a preparation in my collection.

Although the periosteal and central chondromas of the long bones possess many features in common, they exhibit certain contrasts, which have been carefully studied by Dr. S. W. Gross, and which may prove useful in distinguishing them from each other, and from the sarcomatous growths. Thus, the periosteal tumors appear between the tenth and sixty-first years, or, on an average, at the age of twenty-six; nearly two-thirds of all cases are met with in females; pain is present throughout in 47 per cent.; the subcutaneous veins are dilated in 21 per cent.; the skin is variously altered in one example in every ten; spontaneous fracture, or fracture from slight causes, is met with in 5 per cent.; metastatic deposits occur in 3.17 per cent.; and the lymphatic glands are never enlarged. The central tumors, on the other hand, appear between the seventeenth and fifty-ninth years, the average being

Fig. 410.

Cartilaginous Tumors of the Hand.

the thirty-third year; four-fifths of all cases are met with in males; pain is experienced throughout in 30 per cent.; the superficial veins are enlarged in 60 per cent.; the skin is variously altered in one example in every five; fracture is met with in 20 per cent.; metastatic tumors are unknown; and the lymphatic glands are enlarged in one instance in every ten.

A tumor of this kind occasionally attains an enormous bulk, as in a chondroma of the scapula and humerus in a young man of twenty-six, whom I saw at the College Clinic, the weight of the mass being upwards of thirty pounds.

There is a form of this tumor to which, from the superaddition of sarcomatous tissue, the term sarco-chondroma is applied, a striking example of which came under my observation, in 1871, in a strong, robust man, thirty years of age, in connection with the tenth rib, which it involved from its angle almost to its costal attachments. Extending from near the spinal column obliquely downwards and forwards to within an inch of the crest of the ilium in front, it was seven years in attaining its growth, one-half being added during the last twelve months. It was of a flattened, ovoidal shape, with the narrow end below, perfectly painless, very firm, and unadherent to the skin. Excision was effected without any material loss of blood, but during the dissection a portion of pleura, very much thickened, and about the size of the palm of the hand, was unavoidably ex-

posed, although not penetrated, separation being accomplished by enucleation. Death occurred on the twelfth day from pleuro-pneumonia.

The tumor, after removal, was found to weigh two pounds and a half, its greatest longitudinal circumference being twenty inches, and the transverse twelve. It was distinctly lobulated, and was, apparently, composed of two portions; an upper, cartilaginous, finely tuberculated, bright, grayish-white, corresponding with the affected rib; and a lower, of

Fig. 411.

Fig. 412.

Chondromatous Tumor undergoing Ossification.
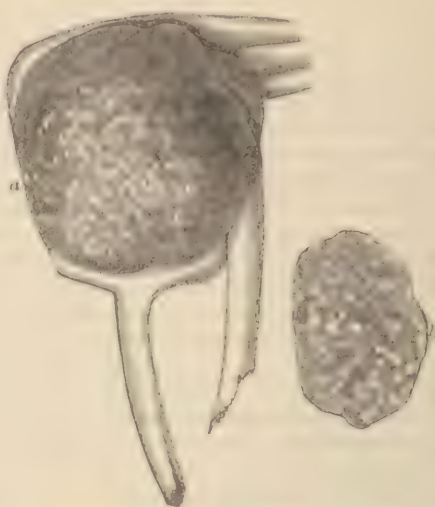
Chondromatous Tumor of the Ribs. *a.* External Appearance. *b.* Internal Structure.

a dense, shining, fibrous appearance, succulent, of a pale straw color, consisting of cartilage cells, most of which were filled with drops of oil, and of an intercellular substance, made up, in great degree, of fasciculated spindle-celled tissue. The more rapidly developed portions of the morbid mass were interspersed with large spindle-cells, mottled with vascular and greenish gelatinous points, and inlaid with cysts of varying sizes, some of which were filled with mucous fluid, while others were undergoing disintegration. There were also, in different situations, islets of hyaline cartilage, calcareous deposits, and delicate masses of bone, with well-marked lacunal cells but no Haversian canals, the whole growth affording a remarkable illustration of the various degenerations which such a tumor occasionally experiences during the progress of its development.

The only remedy for these tumors is free excision or amputation, as when they occupy an extremity. All local and general means, even in their earlier stages, are unavailing.

4. OSTEOID CHONDROMA.

The term osteoid chondroma has been applied by Virchow to those peripheral neoplasms which originate in the ossifying cell-layer existing between the periosteum and the surface of growing bones, and is called by him membranous or osteoid cartilage, since it forms the starting point of ossific processes, as indicated by the normal growth of bone and the development of callus, osteophytes, and other pathological formations, and, for that reason, is the equivalent of cartilage. Holding an intermediate position between osteoma and chondroma, osteoid chondroma is made up of cells, which differ from those of cartilage in being small, fusiform, or round-oval with short prolongations, and devoid of capsules. They lie free in a very dense, striated, but non-fibrillated, sclerosed, or cartilaginous intercellular substance, which is greatly in excess of the cellular elements, although the latter may predominate, and increase in size, in which event the tumor becomes sarcomatous. On section the mass is seen to be extensively pervaded by bone, at one point fragile and porous, at another dense and hard, which forms a delicate skeleton or framework, attached to the surface of the bone. In some specimens the ossific process has advanced so far as only to require the deposition of the salts of lime in the remaining softer portions

of the growth to convert it into an osteoma. It is rich in bloodvessels which penetrate its very substance, in which respect it differs from chondroma.

Osteoid chondroma is seated most frequently on the articular extremities of the shafts of the long bones, and on the lower jaw. Some pathologists, indeed, are disposed to include it among the ossifying periosteal sarcomas, from which they are unable to distinguish it, either by its minute, gross, or clinical features.

Osteoid chondroma does not possess a single element by which it may be diagnosticated from periosteal sarcoma. It is most frequent in young persons; is of a firm consistence, and of an ovoidal or pyriform shape, with a smooth or only slightly uneven surface; grows rapidly, and attains a large volume. Closely connected with the bone, it receives an investment from the periosteum, which, however, may finally give way, and permit the mass to infiltrate the surrounding tissues. The huge dimensions which it may acquire are well illustrated by a case under the charge of Sir Astley Cooper, in a girl, thirteen years of age, in whom the tumor, of twelve months' growth, and occupying the inferior maxilla, measured sixteen inches in circumference. The tongue was pushed not only to one side but backwards into the pharynx, while the epiglottis was recurvated upon the superior aperture of the larynx, death finally ensuing from the combined effects of starvation and respiratory embarrassment. The prognosis is bad, as the tumor is not only liable to recur after removal, but to give rise to metastatic deposits. The only remedy is amputation as far as possible from the seat of the disease, when an extremity is involved, or excision when the lower jaw is affected.

5. FIBROMA.

Fibrous tumors of bones, whether originating in the periosteum or in the endosteum, resemble similar formations in other tissues. As hyperplastic outgrowths of the periosteum, they are met with most frequently in connection with the base of the skull, as polyps, in the antrum of Highmore, and upon the alveolar borders of the upper and lower jaws, where they give rise to one form of epulis. In any of these situations they may attain an enormous size, and commit frightful ravages by their encroachment upon the surrounding structures.

The central or endosteal variety of fibroma is confined almost exclusively to the lower jaw, although it has also been observed in the extremities of the long bones and in the phalanges of the fingers. In the former situation the plates of the maxilla are expanded so as to form a round, or oval, and more or less distinctly lobulated tumor, the interior of which is now and then intersected by osseous spicules.

The treatment of these affections must vary according to their site, complete removal being indispensable under all circumstances, by detachment with suitable instruments or by excision of the entire thickness of the bone, as when they occupy the jaw.

6. MYXOMA.

Pure myxoma of the osseous tissue is very uncommon, the majority of the recorded instances of this affection being due to mucous degeneration of chondromas. A case in which a myxomatous tumor grew from the body of the sphenoid bone, outside of the dura mater, fig. 413, came under my notice in a patient who died at the age of thirty-nine years from epilepsy, produced by a fall twelve months previously. On examination, Dr. Colescott and myself found a lobulated tumor, of irregular form, and about the size of a pullet's egg, which had flattened the Varolian bridge, and had evidently induced the disease in question. It is generally developed from the medullary membrane of the lower jaw, disparting the compact tissue, which it expands into a thin, bony investment, as in other central osseous growths. Its progress is slow, but, as it increases, the bony capsule is finally perforated. It is a strictly local affection, evincing no disposition to return after removal, or to contaminate the neighboring lymphatic glands.

Fig. 413.

Myxomatous Tumor.

7. ANGIOMA.

The only form of vascular tumor met with in the bones is aneurism by anastomosis, to which attention was first clearly drawn by Mr. Stanley. The disease, which exhibits the same general characters as an arterial erectile tumor of the soft parts, and which is represented in fig. 414, has been chiefly noticed in the broad bones, especially those of the cranium of young children. The causes of this lesion are obscure. Any external injury, by disturbing the vascular action of the bone, might produce it.

Fig. 414.

Anastomotic Aneurism of Bone.

The enlargement, even in its early stages, is tense, painful, and attended with distension of the superficial veins, swelling of the surrounding structures, and slight discoloration of the skin. In a short time a deep-seated pulsation or throbbing synchronous with that of the left ventricle, and similar to what is witnessed in some erectile tumors, may be perceived in the affected part. In the advanced stage of the malady the beating is accompanied by a sort of undulating movement, and is easily interrupted by compressing the carotid artery.

When anastomotic aneurism involves the scapula, the lower jaw, or the clavicle, and it is of limited extent, it may be removed. When it is situated in the cranial bones, it gradually destroys the osseous tissue, and ultimately involves the brain and its envelops, rendering interference out of the question. Several cases have been reported in which the carotid arteries were tied for this disease, but in none with any permanent benefit.

8. HYDATID TUMORS.

The bones are occasionally the seat of hydatids, but the occurrence is very uncommon. The first account of these bodies in these situations was given by two Dutch pathologists, Van Vy and Van der Haar, whose observations have since been confirmed by other observers, as Keate, Cruveilhier, and Lucas.

Although it is extremely probable that all the different classes of bones are liable to these formations, they have hitherto been observed almost exclusively in the long and flat bones, particularly in the tibia, for which they appear to have a decided preference. They have been found seven times in the tibia, five times in the humerus, five times in the bones of the pelvis, four times in the bones of the skull, three times in the vertebræ, twice in the femur, and once in the phalanx of the finger. What was formerly known under the vague name of spina ventosa was an osseous tumor which probably occasionally contained bodies of this kind.

These bodies always take their rise from germs contained in the blood developed in the spongy texture of the bones, as this alone affords them an opportunity of growing and expanding, the compact tissue being too dense and firm to admit of their increase. The only exception to this occurs when they form in the frontal sinus, but even here there is no new law in operation, since the cavity in question is, in fact, only a large cell, well adapted as a residence for such bodies. Of the exciting or predisposing causes of these bodies nothing whatever is known; for if, as has occasionally happened, they have formed in a particular portion of the skeleton after the occurrence of a blow, contusion, or other injury, it does not prove that their development was the consequence of such mischief.

Hydatids occur with nearly equal frequency in both sexes; and all the patients in whom they have hitherto been found were adults, excepting four, of whom two were children three and seven years of age. Borchard has recorded a case in which they existed in several situations in the same individual.

Examination has proved that these bodies are veritable acephalocysts, similar to those which occasionally infest the liver, ovaries, lungs, and other internal viscera. Of a spherical or rounded shape, they are sometimes irregularly flattened or compressed,

especially the older ones, and they vary in size from a pea to that of a marble, their dimensions being evidently influenced by their age, and the extent of the cavity in which they are developed. Their number, which is seldom large, is usually in an inverse ratio to their volume. They are inclosed in a sort of parent cyst, soft in structure, thin, and of a whitish appearance, and they float about in the midst of a serous fluid, of a saline taste, and partially coagulable by heat and acids; circumstances clearly betraying its albuminous character.

The cavity in which these bodies are situated is, evidently, in the first instance, simply a cell of the areolar tissue, in which the germ of the parasite is deposited, and in which it is destined afterwards to attain its full development. As its growth proceeds, it presses upon the osseous matter, pushing its fibres farther and farther part, at the same time causing a partial removal of it by the action of the absorbents, until what remains is at length converted into a mere bony sheet, hardly as thick as a piece of parchment, elastic, and crackling under the finger. The shell is lined, as already stated, by a thin, closely adherent membrane, which evidently plays an important part in the development and protection of the new being. Cases occur in which it consists of several compartments, although in general it is unilocular. The bone immediately adjacent to the disease is usually thickened and roughened by irregular deposits.

The *symptoms* attending the formation of these bodies are extremely obscure, and cannot, for a long time, be separated from those which accompany other diseases in and about the skeleton. Their growth is always very tardy, and a number of months generally elapse before there is any pain or discoloration of the surface. The patient is merely aware that there is some tumor, steadily augmenting in bulk, and slowly encroaching upon the surrounding parts; hard and firm at first, afterwards more soft, and ultimately becoming distinctly elastic, and emitting a peculiar crackling sound on pressure very similar to that of dry parchment. When deep-seated, it causes a gradual wasting of the superimposed tissues, the muscles and tendons being spread out in the form of thin ribbons, while portions of the fibrous membranes are actually absorbed. Meanwhile the tumor mechanically impedes the functions of the surrounding parts, pain and tenderness set in, and the skin evinces signs of irritation. At this stage of the complaint the affected bone sometimes gives way under the most trivial accident, refusing afterwards to unite, or undergoing consolidation only after a long while. Occasionally the most prominent portion of the tumor ulcerates, and discharges a part of its contents. The health remains good for years, but in the end it is always much impaired by the local distress.

The most important diagnostic signs of this affection are, the tardy progress of the tumor, the absence of pain and swelling, the change from a hard, incompressible substance to one of comparative softness and even elasticity, and the complete absence of all appearance, both local and constitutional, of malignancy. After all, however, these symptoms are merely of a negative character; for at last the only reliable source of information is the exploring needle, although this also, unfortunately, is not available until the morbid growth has acquired great bulk, and is almost on the verge of bursting. Even the elastic feel and crackling noise which, in the latter stages of the complaint, form such prominent features, are of no diagnostic avail, as they are common to several other varieties of bony tumors, especially the cystic, properly so called.

Hydatid disease of the osseous tissue is always a grave occurrence, not so much on account of the damage to the general health as of the injury it inflicts upon the affected bone, weakening its structure and thus impairing its usefulness, generally to an irremediable extent. In some of the recorded cases the acephalocysts burst into the knee-joint, causing destructive inflammation, while in others the animals perished, and gave rise to high constitutional disturbances, attended with excessive pain and hectic fever.

The *treatment* of this disease is by extirpation, performed early, before there is any serious structural lesion of the bone. The tumor being freely exposed by an incision, either crucial or elliptical, and attacked with the saw, pliers, trephine, or chisel and mallet, as may seem most advisable. Its contents being turned out, the lining membrane of the osseous shell is carefully peeled off, or, if this be impracticable, painted with a strong solution of iodine, to destroy its secreting surface, lest there be a speedy reproduction, if not of hydatids, at all events of serous fluid. The cavity is then filled with oiled lint, and the flaps, being approximated, are lightly held in place with a few strips of adhesive plaster. The cavity gradually shrinks, and a cure is ultimately effected by the granulating process.

When the case is a very aggravated one, involving the entire circumference of the

affected bone, or when the hydatids open into a joint, the only resource is resection or amputation, the former being applicable only when the disease is of limited extent, while amputation is absolutely necessary when it has induced so much disturbance, local and constitutional, as to threaten life.

<div align="center">SECT. XVII.—TUBERCLE.</div>

Tubercles of the osseous tissue are much more common than is generally imagined. The bones usually affected are the vertebræ, the short bones of the hand and foot, and the articulating extremities of the long bones. The particular seat of tubercles is the spongy texture, from the marrow of which they arise, although occasionally they are formed upon the outer surface of the bones, beneath the periosteum.

There are two varieties of form in which this matter is deposited. In one, perhaps the more common, the tubercles are encysted, the inclosing membrane, which varies in thickness from the fifth of a line to half a line, being composed of plastic matter, very soft at first, but gradually becoming harder and harder, until finally, in some cases, it acquires the character of fibro-cartilage. It is of a dull, grayish color, is made up of delicate, inelastic fibres, and is frequently furnished with small vessels, passing into it from the surrounding structures. The number of tubercles is generally small; their size ranges from a pea to that of a cherry; and they are of a yellowish, opaque appearance. When they become softened, as they commonly do in a few months, the pus either works its way out, or it escapes, by a kind of fistulous route, into a neighboring joint, establishing thereby an analogy with pulmonary tubercles opening into the bronchial tubes. Sometimes a spontaneous cure takes place, the tubercle granules being absorbed, and the cavity occupied by the cyst being obliterated by osseous matter.

In the second variety, the tubercular matter is deposited directly into the cells of the osseous tissue, forming grayish, semitransparent, opaline patches, from the one-sixth of an

Fig. 415.

Bone infiltrated with Tubercle.

inch to an inch in diameter. This infiltration, exhibited in fig. 415, is noticed chiefly in the bodies of the vertebræ and in the bones of the tarsus. The bony tissue immediately around is sometimes deeply injected, and the trabeculæ are eroded. In this, as in the preceding variety, the tubercular deposit, after having existed for some time, gradually softens, and the cells in which it was contained are filled with earthy matter. This, however, is not always the case; for now and then the ulcerative process continues until the bone is totally destroyed.

The progress of tubercular disease of the bones is always chronic, although not equally so in both forms, the infiltrated proceeding more tardily than the encysted, and causing generally also a greater amount of havoc in the osseous tissue. There is nothing definite, however, in regard either to the commencement of the softening process, or to the ultimate elimination of the resulting matter from the affected structures. Much will doubtless depend, in every case, upon the condition of the system, the age of the patient, and the presence or absence of complications. As a general rule, from six to twelve months will elapse from the moment of the deposition of the tubercular substance to the completion of the softening process. The pus left by the disintegration of the deposit is similar to that which occurs in the lungs in the advanced stage of phthisis, being of a pale yellowish color, bordering slightly upon greenish, and of a thin, fluid consistence, with small whitish flakes not unlike soft-boiled grains of rice. After an opening has been effected into the abscess, the discharge generally becomes very watery and bloody, as well as irritating, and comes away in large quantities, a number of sinuses often existing in the diseased parts, as if they were necessary to carry off the superabundant secretions. In many cases, broken-down osseous tissue is intermingled with the pus, passing off either as little granules or as minute fragments, which not unfrequently choke up the abnormal track, and thus excite new irritation.

The adjoining cut, fig. 416, from a specimen in my cabinet, exhibits the effects which a tubercular abscess may exert upon the osseous tissue, in causing a well-marked excavation, similar to what occurs in the lungs.

Fig. 416.

The abscess that arises from the disintegration of tubercular matter is the form which is usually met with in bone, the phlegmonous, as stated elsewhere, being of extremely rare occurrence. The symptoms attending it are generally obscure, but its existence may be suspected when, along with the ordinary signs of osteitis, the affected part is the seat of circumscribed, deep-seated, gnawing pain,
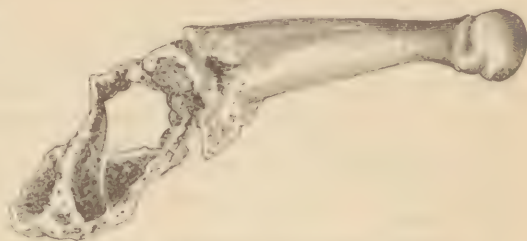
Tubercular Excavation of the Cuneiform Bone.

with excessive tenderness at one particular spot, and a glossy, shining, œdematous condition of the integument. The breaking of the abscess is always preceded by considerable swelling of the soft structures, and by more or less disturbance of the system, the constitution frequently sympathizing severely with the local trouble. In addition to these circumstances, the history of the case, as the age of the patient, the site of the morbid action, and the absence of coexistence of strumous disease in other structures, will generally furnish useful light, and thus materially aid in the establishment of a correct diagnosis.

The *treatment* of tuberculosis of bone does not materially differ from that of tuberculosis generally. As the local deposit is usually merely a reflection of the state of the system, the great object should be to employ such remedies as are necessary to modify this condition of the constitution and to provide for the supply of a better and richer blood. The principal means included under this head are, a well-regulated and adequately nutritious diet, cod-liver oil, and the various chalybeate preparations, either alone, or in union with quinine, mild purgatives, and gentle exercise in the open air.

The local remedies are of the ordinary antiphlogistic character, consisting of leeches, blisters, and tincture of iodine, with early and free incisions of the soft structures to relieve pain and tension. If the existence of an abscess is suspected, the trephine must promptly be employed, the operation and after-treatment being conducted in the same manner as in acute abscess of bone.

SECT. XVIII.—NEURALGIA.

Neuralgia of the osseous tissue is infrequent. I have seen vast numbers of cases of neuralgia of the soft structures in almost every part of the body, but comparatively few of neuralgia of the bones. In nearly every instance that has fallen under my observation the disease was associated with some organic lesion of the affected texture, such as abscess, caries, exostosis, or interstitial deposits into the Haversian canals and cancellated tissue, thereby compressing the vessels and the nerves distributed through their tunics. A lady, aged fifty, had long been afflicted with neuralgia of the cranium, caused by the falling of a window-sash upon the upper and posterior angle of the left parietal bone. The pain, without observing any regularity in its accession, gradually increased in severity, and became at length so intense as to require from one to two drachms of morphia a week, besides enormous quantities of sulphuric ether, even for temporary relief. The seat of pain was a small spot, not larger than the end of a finger, and exquisitely tender to the touch. A disk of bone, embracing the affected portion, being removed with the trephine, an exostosis, not more than the eighth of an inch in thickness, was discovered upon its inner surface, which thus at once explained the nature of the case. Complete recovery followed the operation.

A married woman, aged twenty-eight, had suffered, at times, most acute and distressing pain from a small bony tumor at the anterior and outer part of the lower extremity of the left radius. The tumor had come on about twelve years previously, and had all along been exquisitely sensitive on pressure even on the slightest touch. It projected but little beyond the natural level, and was unaccompanied by any visible change in the soft parts. The pain had been liable to periodical exacerbations, and was often so severe as to deprive the woman of appetite and sleep. The general health had always been good; the complexion denoted a robust state of the system, and the menstrual function was

usually performed with great regularity. Upon removing the tumor, I found that its substance was almost as hard and dense as ivory. The pain at once disappeared, and has never returned.

I have met with a number of cases similar to the last, which may be regarded as, in some degree, typical of this affection as it usually appears in the bones. Most of them occurred in young females, between the ages of fifteen and thirty, without, seemingly, any direct connection with the catamenial function, or any marked hysterical predisposition. In all these cases, the pain was liable to periodical exacerbations, not, however, by any means, always coincident with menstruation, and the parts were exquisitely sensitive under motion and pressure. The pieces that are most commonly affected are the radius, ulna, tibia, fibula, and clavicle, along with the skull and the innominate bones. The coccyx also not unfrequently suffers, especially in married women who have borne children.

Neuralgia of bone may arise spontaneously, or be a result of direct injury, as a blow, wound, or contusion, causing inflammation in the affected part. It may also be produced by a syphilitic taint of the system, as is witnessed in the tertiary form of this disease, in which the pains are not unfrequently of a darting, shooting, lancinating nature, or else dull, heavy, and aching, as in neuralgia of the soft structures. In abscess of bone the suffering is frequently of the same character; hence the difficulty so often experienced in discriminating between the two affections. The disease is frequently associated with neuralgia in other parts of the body.

What the precise nature of the change is which the osseous tissue undergoes in this affection has not been determined. The probability is that it is sometimes altogether functional, while at other times it depends upon interstitial deposits, either as a simple hypertrophy or as a small exostosis, compressing the vessels and nerves at the seat of the disease, and thus causing the excessive pain which so often attends it.

The *treatment* of neuralgia of bone is too often conducted upon empirical principles; a circumstance, doubtless, due to the fact that it is generally difficult, if not impossible, to ascertain the true nature of the disease. In recent cases, especially in such as are directly chargeable to the effects of external injury, a free incision down to the seat of the disease, dividing the periosteum and even the superficial layer of the bone, will occasionally effect a prompt cure, especially if the wound be kept open for some time with stimulating dressings to promote discharge. Now and then a small issue, made with the actual cautery, answers an excellent purpose. When the cause is of a syphilitic nature, iodide of potassium and mercury are the best means of relief. Quinine, arsenic, and strychnia are indicated when the disease is of miasmatic origin. In obstinate cases, the only reliable plan is removal of the affected bone with the trephine or other suitable instrument, as the object is to get rid of the compressing agent, whether this is merely simple hypertrophy of the part, or an exostosis, properly so termed. The late Dr. Nott, of New York, twice excised the greater portion of the coccyx for the cure of this disease, and a similar operation has been performed by others, although not always with a satisfactory result.

SECT. XIX.—FRACTURES.

1. GENERAL CONSIDERATIONS.

There is no class of injuries which a practitioner approaches with more doubt and misgiving than fractures, or one which demands a greater amount of ready knowledge, self-reliance, and consummate skill. Constant in their occurrence, and often extremely difficult of diagnosis and management, they frequently involve consequences hardly less serious and disastrous to the surgeon than to the patient himself. If I were called upon to testify what branch of surgery I regarded as the most trying and difficult to practise successfully and creditably, I should unhesitatingly assert that it was that which relates to the present subject, and I am quite sure that every enlightened practitioner would concur with me in the justice of this opinion. I certainly know none which requires a more thorough knowledge of topographical anatomy, a nicer sense of discrimination, a calmer judgment, a more enlarged experience, or a greater share of vigilance and attention; in a word, none which demands a higher combination of surgical tact and power. As for myself, I never treat a case of fracture, however simple, without a feeling of the deepest anxiety in regard to its ultimate issue; without a sense of discomfort, so long as I am conscious that, despite the most assiduous attention and the best directed efforts, the patient

is likely to be lame and deformed for life. A crooked limb, whether rendered so by injudicious treatment or not, is an unpleasant sight to a sensitive surgeon, inasmuch as it continually reminds him of his bad luck or want of success. I do not wish by these remarks to be understood to say that it is always in his power to cure these accidents without deformity or impairment of function. Such a view would be contrary to experience and common sense. There are many cases of fracture which do not admit of any other result, however attentively or skilfully they may be treated ; and there are not a few which turn out badly, disgracefully badly, simply because of the want of proper coöperation of the patient. In such cases no surgeon is responsible.

A fracture is a solution of continuity of the osseous tissue, or, in other words, a division of the bony fibres, occasioned by external violence or muscular contraction. The lesion presents itself in various forms, of which the principal are the simple, compound, comminuted, impacted, and complicated. To these may be added the incomplete fracture, in which a bone, instead of being entirely broken, is divided only in a portion of its diameter.

A fracture is said to be simple when there is no wound of the soft parts directly over the ends of the fragments, so as to expose them to view, or permit them to be felt. It is, in fact, a subcutaneous wound of a bone, and nothing more. The case is a simple one, so far as the bone is concerned, even if there be a wound in the immediate vicinity of the fracture, provided it has no direct communication with it. A fracture is compound when there is an opening in the skin and muscles extending down to the bone, the ends of which often protrude through the wound, girted, perhaps, by its edges. When a bone is broken into a number of pieces, the term comminuted is applied to it. The word impacted is employed to signify that the extremity of one fragment is forced into that of the other. Finally, fracture is complicated when it is associated with a dislocation, a wound, hemorrhage, laceration, or other mischief. It will greatly facilitate the study of the subject if all these terms, excepting the first and last, be discarded. Hence, after some general observations, I shall treat first of simple fractures, and afterwards of fractures complicated with other lesions.

All the bones of the body are liable to be broken, although not by any means with equal frequency. Those which are most prone to suffer in this manner are the long bones of the extremities, particularly those of the leg and forearm. The clavicle is also often fractured. The scapula, the two jaw-bones, the sternum, ribs, innominate bones, vertebræ, sacrum, and coccyx, together with the bones of the hand and foot, are rarely broken, owing either to their protected situation, to their mobility, or to the manner in which they are united to each other and to the surrounding parts. It may be stated also, as a general law, that the long bones are more liable to give way at or near their middle than at their extremities ; a circumstance of some importance in a diagnostic and practical point of view.

The relative frequency of fractures of the bones of the superior and inferior extremities varies in different institutions and in different localities, according to the nature of the occupations of those who are the subjects of them. The following table, composed of the statistics of four different hospitals, shows the preponderance to be very slightly in favor of the lower limbs :—

	Cases.	Upper extremity.	Lower extremity.
Pennsylvania Hospital	7670	3760	3910
Hôtel-Dieu, Paris	1856	850	1006
Middlesex Hospital, London	1280	764	516
Naval Hospital, Calcutta	1346	665	681
	12,152	6039	6113

Respecting their direction, fractures may be oblique, transverse, or longitudinal. Of these varieties, the first is by far the most common, although it is impossible, from the want of statistics, to estimate its relative frequency. My experience is that transverse fractures, except in young children, are extremely rare, and even in them they are by no means frequent. In the extensive osseous collection of Dr. Mütter, now in the College of Physicians, there is not a solitary specimen of the kind ; and my own is equally barren. These remarks apply, of course, only to fractures of the long bones, and especially to fractures of their shafts ; for in the short and flat bones such an occurrence is not without a certain degree of frequency. There is reason to believe that many of the so-called cases of transverse fractures of the shafts of the long bones are in reality oblique fractures, approaching more or less closely to the horizontal line, and yet not strictly falling within it. There are few practitioners, I imagine, who will not coincide with me in this view,

and who, like myself, have not had frequent occasion, upon further and more thorough exploration, to correct their diagnosis in cases of this description. If the question were one solely of a speculative nature, it would be of little consequence; but when its practical bearing is considered, it is impossible to lay too much stress upon it. As it will, however, be again adverted to in speaking of the treatment of fractures, nothing further need be said respecting it here. The annexed cut, fig. 417, conveys a good idea of an oblique fracture.

Fig. 417.

Oblique Fracture of the Forearm.

Longitudinal fractures are extremely rare, and are nearly always produced by gunshot violence. They are chiefly met with in the humerus, femur, and tibia. The fracture occasionally extends nearly through the entire length of the shaft of a bone; but generally it is not more than a few inches long. Now and then a fissure of this kind, after having passed a certain distance, runs off in an angular direction towards the surface of the bone, where it terminates, as in fig. 418. A longitudinal fracture sometimes occurs at the inferior extremity of the humerus, and also, but more rarely, at the lower end of the femur, separating one of the condyles of these bones, or even both of these protuberances, especially if there be at the same time a horizontal or oblique fracture a short distance above the corresponding joint. A longitudinal fracture is occasionally met with in the patella. Bone fissures, which are often, if, indeed, not generally extremely difficult of diagnosis, are occasionally compound, and are then usually of a very serious character, evidently from exposure of the medullary canal, as they are very liable to be followed by erysipelas, pyemia, osteomyelitis, and death.

Fig. 418.

Longitudinal and
Oblique Fracture.

The extremities of the fragments of a broken bone exhibit much diversity in regard to their form and size; in general, one is much larger than the other, as well as more sharp, rough, and irregular, as in fig. 419. In the majority of cases, they have a ragged, serrated, or denticulated appearance, the projecting pieces of one end corresponding with the depressions in that of the other. This arrangement, which is produced by the irregular division of the osseous fibres, bears no little analogy to that which occurs in the edges of a lacerated wound. The truth is, to carry out the analogy still further, an oblique fracture is nothing but a lacerated wound of the osseous tissue, which presents the same difficulty in regard to its perfect coaptation and speedy reunion as a similar lesion in the skin and muscles. The irregularities upon the extremities of the fragments are often sadly in our way, offering a great obstacle to the successful reduction and subsequent maintenance of the parts. Sometimes, indeed, the projecting pieces are so long and sharp

Fig. 419.
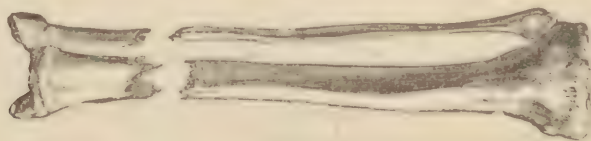
Appearances of the Ends of the Fragments.

as to pierce the integument, or require to be sawed off before the bone can be properly set. Such an occurrence is not uncommon in fractures of the tibia, and it is also witnessed, although less frequently, in the femur, radius, and clavicle.

Sometimes the fracture is *impacted*, the end of one fragment being forcibly driven into the other, so as to be, as it were, interlocked. Such an occurrence, of which fig. 420

affords an excellent illustration, can only arise, as a general rule, in those bones which contain an extraordinary amount of areolar substance, as the head of the humerus, the neck of the thigh-bone, and the lower extremity of the radius.

As a bone may give way at any part of its extent, at its middle, or at either end, it follows that the two fragments are rarely of the same length; instead of this, there is often a most marked disparity, as is exemplified in fractures of the extremities of the long bones, as the femur, in which, especially in fractures of its neck within the capsular ligament, the superior fragment is sometimes hardly an inch and a half in length, while the other is perhaps upwards of a foot and a quarter. Fracture of the olecranon affords a similar illustration. Such an occurrence is not without its influence in regard to the treatment and final issue of the lesion; for the nearer, as a general rule, the length of the fragments corresponds, the easier, other things being equal, will it be to maintain their apposition, and to secure prompt and perfect union.

Fig. 420.

Impacted Fracture of the Neck of the Femur.

A fracture may be single or multiple; that is, a bone may break at one or more places, sometimes as many as three, four, or even five; in other words, it may literally be crushed and comminuted. Such lesions are generally the result of inordinate violence, and are, therefore, very liable to be followed by serious consequences; often, indeed, by loss of limb and life.

In fractures of the leg and forearm, affecting both bones, it is extremely rare to find the injury situated on the same level; on the contrary, there is generally a considerable distance between the two fractures, amounting, according to my observation of numerous cases, ordinarily to from one to two, three, and even four inches. The interval is usually considerably greater in the leg than in the forearm, probably because of the greater inequality in the size of its two bones. What the cause of this occurrence is it is not easy to determine; but it may be supposed that it is due mainly, if not entirely, to the manner in which these pieces are respectively articulated to the wrist and ankle joints, in consequence of which the violence occasioning the lesion is transmitted more forcibly along one bone than the other, thereby compelling the former to yield before the latter. Thus, as the tibia is more intimately connected with the foot than the fibula, it follows, if this explanation be correct, that it ought to break lower down than the fibula, and this, I believe, is what usually happens, although there are many exceptions.

Fractures occur at all periods of life. During delivery, the bones of the arm and leg are occasionally broken in rude attempts at extraction. An infant, four weeks old, was brought to me on account of a fracture of the shaft of the right femur, caused two days previously by a child rolling over it in bed. The thigh was much swollen, and at least an inch and a half shorter than the sound one; all the extension and counterextension that I could make with my hands failed to restore it to its normal length. Fractures occasionally occur in the foetus in the womb. Chaussier met with a remarkable example of this description, in which each of the long bones had suffered more or less from these lesions, some of which were recent, others beginning to unite, while others were consolidated. The infant survived its birth only twenty-four hours. Analogous cases have been reported by other observers. In very young children the bones, owing to their softness and flexibility, instead of breaking, are very apt to bend, or give way at their epiphyses; in elderly subjects, on the contrary, they are very light and brittle, from the rarefaction and fatty degeneration of their substance, and are, therefore, extremely liable to yield under the slightest violence. Thus, a fracture of the neck of the femur within the capsular ligament is often produced by a mere twist of the thigh in bed, by entangling the big toe in a fold of the carpet, or by stepping off the curbstone.

Statistics have been collected which show that fractures of the upper extremity before the end of the fifth year occur with nearly equal frequency in both sexes; between this period and the fiftieth year they are most common in the male, and after the fiftieth year in women, owing to the remarkable frequency of fractures of the lower extremity of the radius and of the neck of the femur. Children are particularly liable to fractures of the clavicle, and to separation of the condyles of the humerus.

Causes.—The causes of fractures are divisible into predisposing and exciting; the first having reference to the part and system, or to local and constitutional circumstances, the second to external violence and muscular action.

The conformation, situation, and office of certain bones are so many predisposing causes

of fracture. Thus, as was before stated, the long bones, which are the great levers of locomotion, and which, in consequence, are constantly under the influence of large and numerous muscles, are much more subject to this accident than the short or flat bones, which are more passive in their character, as well as more closely articulated together, so that any force that may be communicated to them is more easily broken. The body of the scapula is seldom broken, because it is not only thickly covered by muscles, but, having no fixed point below, it is incapable of being injured by any shock transmitted by the hand, elbow, or shoulder. The acromion process, however, owing to its exposed situation, is not unfrequently fractured; while the coracoid process, protected by the deltoid, clavicle, and head of the humerus, rarely suffers from this cause. The radius, being articulated with the hand, is more liable to break than the ulna; the fibula, owing to its slender form and brittle texture, is oftener broken than the thick and heavy tibia; and every surgeon knows how very prone the collar-bone is to fracture, its exposed situation, the peculiarity of its conformation, and its connection with the sternum and scapula, rendering it particularly obnoxious to this occurrence.

Of the influence of age, in promoting the occurrence of fracture, mention was made in a previous paragraph. As life advances the bones not only become more brittle, but the muscles, the active agents of locomotion, lose their elasticity and suppleness, thus rendering persons more liable to falls, and, consequently, more prone to the accident in question.

Various diseases or states of the general system are usually regarded as predisposing causes of fracture. Of these, the most common are syphilis, carcinoma, sarcoma, scurvy, rickets, and osteomalacia.

A *syphilitic* state of the system, involving the skeleton, may so affect some of the bones as to render them abnormally fragile, and predispose them to this occurrence, as in the case of a man, thirty-one years of age, whom I attended for a fracture of the body of the right humerus, caused a short time previously, by throwing a small chip at a dog. He was perfectly well at the time, with the exception of some nocturnal pains in the arm and forearm. He had had primary syphilis seven years previously, and had been treated with mercury. The bone united in five weeks.

Carcinoma, as stated in a previous page, may so alter the osseous tissue as to render it preternaturally brittle, and cause it to yield under the slightest accident. Such an occurrence, indeed, is probably not so uncommon as is generally supposed. I have myself, however, seen only one instance of it. The patient was a lady, seventy-three years old, from whom I had removed, nine months previously, the left mammary gland, on account of scirrhus, under which she had labored for nearly three years. The wound healed kindly, but, some time after, the disease reappeared at the cicatrice, and gradually carried her off, not, however, before she had become extremely emaciated and bedridden. During the last month of her life, she complained of almost constant pain in the right thigh, deep-seated, and particularly severe at night; and three days before she expired, in an attempt to turn in bed, the femur gave way immediately above its middle. The limb was free from swelling and discoloration. No carcinomatous matter could be detected in the affected bone, which was quite soft, humid, and brittle, for some distance above and below the seat of fracture.

Sarcoma, especially when it takes its rise in the medullary structure of a bone, is often followed by fracture, the affected bone frequently giving way under its own weight, or under the most trivial accident.

Of the influence which *scurvy* exerts upon the osseous tissue, in predisposing it to fracture, the modern practitioner has little opportunity of judging, as the disease at the present day seldom appears in that violent form which characterized it in former times. As described by the older writers, it was often attended with the most horrible ravages, in which the skeleton not unfrequently participated, the synovial membranes, cartilages, and ligaments being ulcerated, and the epiphyses separated from the bones.

There are certain states of the skeleton, including *rickets*, in which the bones are so very brittle as to break under the most trivial injury. Cases are recorded in which from these and other causes, nearly every one of the long bones was broken, not only once, but a number of times. What is remarkable in these cases is that recovery is usually quite as rapid as in ordinary fractures. My collection contains a part of the skeleton of an old woman, who, in falling from a third-story window upon the pavement below, received not less than eighty-three fractures, involving the ribs, vertebræ, the scapula, the bones of the pelvis, and most of the bones of the extremities.

In *osteomalacia* fractures are sufficiently common in all parts of the skeleton, especially in the long bones of the extremities. In this disease the osseous tissue parts with its

earthy salts, and is rendered so soft and brittle as to give way under the slightest injury; often, indeed, under mere muscular contraction.

Charcot has reported a case of locomotor ataxia in a woman who suffered from numerous fractures of the femur and of both bones of the forearm. It is highly probable that diminished nerve power not unfrequently acts as a predisposing cause of such lesions.

Gout and *rheumatism* are sometimes enumerated as predisposing causes of fracture, and the following case, which I saw with Dr. Metcalf, would seem to countenance the possibility of such an occurrence. The patient, a common laborer, aged thirty-two, had always enjoyed good health until two years and a half before, when he was attacked with articular rheumatism, affecting the principal joints, first of the superior, and then of the inferior extremities, where it had continued for the last twelve months. The only cause which could be assigned for his suffering was exposure to cold and fatigue in a pork-house, where he had worked for fourteen successive winters. In December, 1855, he broke his thigh-bone, at the junction of the lower with the middle third, while pulling off his boot with his hands, the foot being at the time bent at a right angle with the leg. No pain or swelling followed the accident. The most remarkable feature in the case, when Dr. Metcalf first saw it, was the imperfect aëration of the blood, as indicated by the livid state of the face; the bowels were torpid, the tongue was coated, and there was considerable emaciation, but no disease of the heart and lungs. No chalky deposit existed in the joints and there was, so far as could be ascertained, no syphilitic taint. At the end of a month and a half, the parts being united, the dressings were removed, and the man was permitted to walk about on crutches. A week after this, he struck the affected thigh slightly against the rail of the bed, fracturing the bone at its upper third. Union took place within about the same time as before, the quantity of callus in each instance being uncommonly large.

The osseous tissue is sometimes remarkably *brittle* without any obvious cause. A gentleman, a patient of mine, fifty-four years of age, broke the right femur near its middle in the act of drawing off his boot, the leg being at the moment placed over the other. He heard a loud noise, and the limb became immediately useless. He had labored for a number of years under diarrhœa, but was in other respects well. At Guy's Hospital, London, a similar case occurred in a healthy man, of temperate habits, while engaged in raising his leg across the other to look at the sole of his foot.

The *exciting causes* of fracture are two, external violence and muscular contraction. The former, which is by far the more common, may act upon a bone either directly, or indirectly, through some other bone. In the first case, the force is applied to the bone itself, as in fracture of the jaw from the kick of a horse, or in fracture of the leg from the passage of the wheel of a carriage. Most fractures are of this description, and they are, therefore, generally complicated with more or less injury of the soft structures. In the other case, the force, instead of being applied immediately to the bone, is transmitted to it through another bone, or perhaps a chain of bones. It is in this way that the radius is so frequently broken just above the wrist by falls upon the hand, the force being concentrated upon its extremity, in consequence of the manner in which it is articulated with the carpus, while the ulna, which is but slightly connected with it, generally escapes. Fracture of the clavicle affords an instance of a bone being broken by indirect mechanical violence operating at two opposite points. Thus, in falls upon the shoulder, the sternal end being impelled by the weight of the body, and the acromial end by the object against which it strikes, the bone, acted upon by the two forces, gives way at its weakest part, which is usually about its middle. When a bone is very brittle, the slightest external violence may be sufficient to break it. In old people, the neck of the femur is frequently fractured by the merest twist of the limb in bed, or by stepping carelessly out of bed upon the floor.

A lady, eighty years of age, a patient of mine, while apparently in excellent health, broke her thigh bone in a fall in walking across her room. Fractures occasionally occur during parturition from violence inflicted upon the child by the accoucheur, or from the pressure exerted upon it by the contraction of the uterus.

It is not often that a bone is broken by muscular action, and yet such an accident is not, perhaps, as uncommon as is generally imagined. I have myself met with several examples of it. In three, the subjects were remarkable for their health and muscular development, and the fracture in each was produced while they were engaged in feats of strength, in which the elbows were planted firmly upon a counter, and the hands interlocked with each other. While the muscles of the arm and forearm were in a state of the utmost tension, the humerus snapped off suddenly, with a loud noise; in two cases at its

middle, and in the other at its inferior extremity. In another case, the fracture, also seated in the humerus, was caused by throwing a small chip at a dog. In this instance, alluded to in a previous paragraph, the bone had suffered for a considerable time under nocturnal pains, and had, no doubt, been rendered brittle by the effects of the syphilitic virus. The patient, who was thirty-one years of age, was otherwise in good health, but the muscles of his arm were rather soft and flabby. Dr. Hewson Bache has related to me the particulars of the case of a lady, ninety-seven years old, who broke her humerus in the act of throwing the arm about. She died seven weeks after the accident, without any union of the fracture.

Mere muscular contraction is sometimes sufficient to break the femur, as in the case of an eminent physician of Buffalo, who fractured this bone in the act of throwing a tenpin ball. A similar accident occurred in this city, in a gentleman, aged fifty-two, apparently in the most perfect health at the time. The femur gave way a short distance below the great trochanter, at a moment when the limb was strongly rotated upon its axis. Dr. Lente has recorded the case of a boy, twelve years of age, who broke both his thigh-bones during a severe epileptic convulsion. The patella and olecranon are frequently fractured by the action, respectively, of the extensor muscles of the thigh and arm.

From some of the above cases it is evident that a diseased state of the bone is not at all necessary to the production of this accident by muscular contraction, although such a change is perhaps generally present at the time of the fracture, and, therefore, deserves to be considered as a predisposing cause of it.

2. SIMPLE FRACTURES.

The symptoms of simple fracture may be considered, first, in relation to the broken bone itself; secondly, in relation to the soft parts; and thirdly, in relation to the constitution.

So far as the affected bone is concerned, there are only three symptoms which are at all reliable as evidences of the existence of fracture, namely, crepitation, deformity, and preternatural mobility.

Crepitation is the peculiar noise that is caused by rubbing the two ends of the broken bone against each other, and is always, when well marked, characteristic of the nature of the injury. In general, it can be both heard and felt. In order to produce it, it is necessary that the ends of the fragments should be at least partially in contact, and hence, to effect this object, the surgeon is often obliged, as a preliminary step, to extend and counter-extend the affected limb. For this reason it is always absent in impacted fractures, while in fractures of the leg and forearm, involving only one of the bones, it is usually very faint and indistinct from the difficulty of moving the broken pieces upon each other. Much swelling, great depth of tissue, or the interposition of blood, muscle, or other matter may also obscure the crepitation.

Deformity, although not invariably present, is generally one of the most prominent symptoms of fracture. It occurs in different forms, as in shortening, or in angular displacement, usually at the time of the accident, the cause which produces the fracture being also the cause of the distortion. Occasionally, however, it does not come on until several hours, or, perhaps, even several days after; as, for example, in a partially impacted fracture of the neck of the thigh-bone, in which the patient may be able to walk some distance, and yet the limb retain its normal shape. The degree and character of the deformity are greatly influenced by the nature and situation of the fracture. Thus, the more oblique the fracture is, the greater, as a general rule, will be the displacement of the ends of the fragments, and, consequently, also, the distortion of the limb. Sometimes, as in fracture of the patella, the olecranon, and calcaneum, the deformity manifests itself by a vacuity or hollow at the natural situation of the bone, and by an unusual protuberance upon the lower part of the thigh, arm, or leg, caused by the separation of the upper fragment by the action of the extensor muscles. Finally, the deformity may be much increased by extravasation of blood, or by effusion of serum and lymph consequent upon the resulting inflammation.

Preternatural mobility is, next to crepitation, the most important and reliable symptom of fracture. There are few instances in which it is wholly absent, while in the great majority it exists in a well-marked, if not in a high, degree. It usually appears immediately after the occurrence of the accident, and continues, to a greater or less extent, until the completion of the consolidation of the fracture. In the impacted fracture it may be entirely wanting, or remain absent until the ends of the fragments are unlocked. In fracture of the leg and forearm, involving only one bone, the degree of mobility is some-

times very slight, the sound bone impeding, or altogether preventing, the motion of the affected one.

In every fracture produced by external violence, whether applied directly or indirectly to the part, there must, of necessity, be a certain degree of contusion of the soft structures at the seat of the injury. It may be limited to the skin and subjacent connective tissue, or it may extend deeper, and involve the muscles, aponeuroses, vessels, nerves, periosteum, and even the bone itself. In consequence of this occurrence, there is not unfrequently a considerable effusion of blood beneath the skin, and in the connective tissue of the muscles, causing distension and sometimes discoloration. For the same reason, there is generally a good deal of pain, often of a sharp, spasmodic character, which is aggravated by the slightest motion of the parts, and by every attempt at exploration. It has its seat rather in the soft structures than in the affected bone, although the latter generally participates in it, and by the sharpness of its extremities frequently increases its severity. A short time after the accident, swelling usually sets in, and often proceeds to a considerable height, its degree being greatly influenced by the amount of injury sustained by the soft parts, by the motion to which the fractured bone is subjected, and by the state of the system at the time of the accident. As a general rule, it may be affirmed that the pain and swelling are less in fractures produced by muscular contraction than in fractures caused by mechanical violence, whether directly or indirectly applied.

Inability of motion in the affected bone, and in the portion of the limb articulated with it, is generally a prominent symptom. Cases, however, occur in which it is either very slight or entirely absent. In an impacted fracture of the thigh-bone, for instance, a patient will sometimes walk a considerable distance without the slightest assistance even from a cane, and in fracture of the clavicle I have repeatedly seen him carry his hand to his head, and even circumduct the arm.

Another symptom, consequent upon fracture, is spasm of the muscles at the seat of the injury; it is most common in nervous, irritable persons, and generally comes on within a short time after the accident. When severe, as it frequently is, it constitutes a source of great suffering. It is aggravated by motion and inflammation, and may continue, with more or less interruption, for several hours, if not days.

Finally, the patient often experiences a sense of numbness in the affected part, reaching frequently to the distal extremity of the limb. This may be caused either by the injury sustained by a nervous trunk at the time of the accident, or by the compression of the soft parts by extravasated blood or by the ends of the broken bone. Sometimes it does not arise until inflammation has supervened, and then it is generally owing to the presence of an unusual quantity of serum and lymph.

The amount of constitutional disturbance in fracture varies, in different cases, from the slightest exaltation of the normal action to the most intense excitement, depending mainly upon the nature of the fracture, the degree of injury sustained by the soft parts, and the state of the system at the time of the accident. In very many cases there is an entire absence of traumatic fever, while in others it is present in a very high degree, the pulse being strong and frequent, the countenance flushed, the skin hot and dry, the thirst intense, the appetite and sleep much impaired, if not totally suspended, and the temperature above 100° Fahr. In the more violent forms of fracture, the patient often experiences severe shock, from which he may not fully recover for many days, or which may even terminate in death. Whenever there is much constitutional disturbance, the affected limb will be apt to be in a high state of inflammation, the parts be hot, swollen, painful, and, at times, even covered with small vesicles, such as a heedless observer might easily mistake for the phlyctenulae which so often announce the occurrence of gangrene. Pyemia is uncommon in simple fractures.

Displacement of the Ends of the Fragments.—Displacement of the fragments shows itself, as already stated, in two principal directions, the longitudinal and horizontal. Of these, the former is by far the more common, as it is present, to a greater or less extent, in nearly all cases of oblique fracture, in whatever portion of a bone occurring. It is produced by the overlapping of the extremities of the fragments, the lower being drawn above the upper, or the one riding over the other, as it is sometimes expressed. The extent of this form of displacement varies from the slightest possible change in the length of the affected bone to two, three, and even four inches, which may be regarded as its maximum. It is generally most conspicuous in fracture of the femur and humerus, while in fracture of the forearm and leg, affecting only one bone, it is either very slight or totally wanting. Finally, the displacement may be lateral, or posterior, according to the nature of the exciting cause.

In the horizontal displacement, the lower fragment may form an angle, more or less acute, with the superior, thereby giving the bone an arched appearance; or, the two pieces remaining in contact with each other, the inferior one may perform a rotary movement, while the other continues perfectly stationary. In some cases, as in fracture of the lower end of the radius, there is often considerable lateral displacement, and similar phenomena are apt to occur in fracture of the tibia and fibula at or near the ankle-joint.

The causes of displacement are muscular action, mechanical violence, and the weight of the limb connected with the broken bone. Of these the first is the most common, and it need hardly be added that a knowledge of the fact is of the greatest practical importance in regard to the proper management of the injury. In some instances the displacement is entirely produced by the vulnerating body. Thus, in fracture of the nose, the blow which inflicts the injury also displaces the fragments. The wheel of a carriage passing over the leg may not only break its two bones, but likewise cause great deformity by forcing asunder their extremities. Finally, the displacement may be occasioned by the weight of the limb connected with the injured bone, as in fracture of the clavicle, in which the outer fragment is drawn downwards and inwards by the weight of the shoulder and arm.

Diagnosis.—The most valuable symptoms of fracture, diagnostically considered, are, crepitation, deformity, and preternatural mobility. The coexistence of these symptoms is unmistakably denotive of the nature of the accident, but, unfortunately, they are not always associated; one or even two may be absent, and, therefore, a case that ought to be treated in the most prompt and decisive manner, may, for the want of a correct appreciation of its character, be either entirely neglected, or, at all events, grossly mismanaged. Besides, the symptoms here enumerated may be simulated by other accidents, especially dislocation, and certain affections of the joints.

The crepitation of fracture is sometimes imitated by the grating produced by an effusion of plastic matter into a joint, the sheath of a tendon, or a synovial bursa; and the difficulty may be still further increased, if, under such circumstances, the suspected fracture is situated near a large articulation. In general, however, it will be sufficiently easy to distinguish between them by a consideration of their respective characters. In fracture, the crepitation can be both felt and heard; it is dry, coarse, or rough, resembling the sensation and noise produced by rubbing two unequal surfaces against each other. The crepitation from plastic matter, on the contrary, is of a finer quality, or more faintly marked, and may be likened to the feel and noise caused by gently rubbing over each other two pieces of sole leather; in a word, it lacks the roughness and distinctness of the other. Moreover, it must be remembered that it is never present until after the occurrence of inflammation, whereas the other always exists the very moment after the accident. Crepitation, it is true, might be produced as a consequence of previous disease, and the possibility of such an occurrence should not be lost sight of in our examinations. Finally, when the case is obscure, the crepitation may sometimes be detected by the aid of the stethoscope, especially when the bone is thickly covered by muscles, as in fracture of the neck of the femur within the capsular ligament, or in fracture of the ribs in corpulent subjects. This mode of examination was originally suggested by Lisfranc, but as the expectations held out by him have not been realized, few practitioners of the present day resort to it.

The deformity in fracture manifests itself either in shortening, in lateral displacement, or, as not unfrequently happens, in the two united. Elongation is never present, in which respect fracture differs from certain forms of dislocation, in which lengthening is a prominent symptom. The degree of shortening varies from a few lines to several inches, and is, therefore, an event of much diagnostic value. It may exist from the commencement of the accident, or it may not show itself until some time after its occurrence, being materially influenced by the action of the muscles, and the nature of the treatment. Whatever the degree of the deformity may be from these causes, it may always be effectually removed by extension and counterextension, either alone or aided by pressure; but as soon as these forces cease to operate, it is usually immediately reproduced, which is not the case in dislocation. Here, the reduction having been effected, the parts generally retain their relations until some new cause produces a new displacement.

Too much stress cannot be placed upon preternatural mobility as a sign of fracture. Next to crepitation, it is unquestionably the most important diagnostic symptom. There may be unnatural latitude of motion in a dislocation, but this can only happen when the accident is attended with extensive laceration of the ligaments of the joint; in ordinary cases there is either an absence of motion, the displaced bone being firmly fixed in its

new position, or the motion is so slight as to bear only a faint resemblance to that observable in fracture.

The "physiognomy," or general expression of the affected parts, as in fig. 421, often affords valuable diagnostic aid. The deformity, for example, of the hand and wrist, in fracture of the lower extremity of the radius, the eversion of the toes in intracapsular fracture of the femur, and the shortened and retracted appearance of the arm in fracture of the humerus, are generally unmistakable evidences of the nature of the accident. The manner in which the patient inclines his head and supports the elbow and forearm in fracture of the clavicle, is too significant to be overlooked by any one who has ever witnessed it. The peculiar aspect and attitude of a broken thigh, conjoined with the utter helplessness of its muscles, or the absence of all voluntary power, are signs which seldom admit of misinterpretation.

Fig. 421.
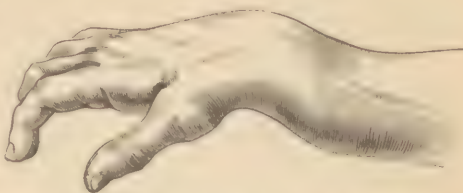
Fracture of the lower End of the Radius.

In fracture without displacement there is sometimes a persistent soreness or tenderness on pressure with the finger at the site of the injury, which, with proper care in the examination, may lead to useful diagnostic information. I have seen this repeatedly in fracture of the clavicle in children, and also in fracture of the bones of the forearm in fat, elderly subjects, and, therefore, look upon it as a most valuable symptom where the ordinary means of recognition fail.

The pain, swelling, and loss of function, present in suspected fracture, are of no practical value, as similar phenomena are produced by other injuries, as contusions, wounds, sprains, and dislocations. Their occurrence being wholly accidental, must, therefore, not influence the surgeon in his attempt to form a correct estimate of the true nature of the case, or the relative value of the symptoms of this and analogous affections.

In fractures of the inferior extremities accurate measurement must not be neglected, similar to those indicated in a former chapter. A very safe and excellent plan is that suggested by the late Professor R. O. Cowling, of Louisville, Kentucky. The patient lying upon a hard, level surface, and the parallelism of the iliac spines and the proper extension of the limbs being looked to, a tape is carried from the umbilicus around a corresponding part of the sole of each foot, and back again to the point of departure. The reference, however, between the two measurements thus obtained represents twice the amount of difference which exists in the length of the limbs, a circumstance that must be borne in mind in determining the actual amount of shortening. Ingenious contrivances for ascertaining the relative lengths of the lower extremities have been devised by Dr. H. Z. Gill, of Illinois, Dr. John Bartlet, of Chicago, Dr. Morton, and several other surgeons.

Mode and Time of Examination.—Although the symptoms which have now been described will generally be sufficient, along with a careful consideration of the history of the case, to enable the surgeon to determine the diagnosis of this lesion, especially if he takes the trouble of comparing them with the symptoms of other accidents, it will, nevertheless, be proper, in concluding these remarks, to say a few words respecting the manner of conducting the examination of the affected parts, as the ultimate issue of the case will greatly hinge upon this circumstance.

Few practitioners know how to examine a broken limb. They take hold of it as if they were afraid of causing suffering, and it is, therefore, not surprising that the result is often most disastrous. I am far from wishing to be understood as being an advocate of rough surgery—on the contrary, no one deprecates it more than I do—and yet there are times and circumstances when the best interests of the patient demand that he should be most thoroughly examined, no matter what amount of pain he may be compelled to undergo. But there is no longer any need of such infliction now that suffering can be prevented by anæsthesia. The patient being rendered insensible, perquisition is performed at the surgeon's leisure, slowly and deliberately, and with an eye to the ultimate result, not forgetting self. The sooner such manipulation is instituted the better, for there will then be less likelihood of inflammatory swelling and other obstacles calculated to embarrass our progress or to obscure the diagnosis. Fractures of the shafts of the bones will rarely offer any difficulty, inasmuch as their symptoms are generally so well marked that the most casual inspection will be sufficient for their detection. But it is different when the lesion involves their extremities. Here the most laborious and painstaking

examination sometimes hardly enables the practitioner to form an accurate judgment respecting the real nature of the injury. Under such circumstances, therefore, he must not content himself with one or two trifling explorations; he must handle the parts again and again, until he has thoroughly established the diagnosis.

For the reason already assigned, the parts should always be examined as early as possible after the infliction of the injury, but no exception should, in my judgment, be made even when some time has elapsed, and a good deal of swelling has supervened; for it is impossible that a broken bone, or the parts by which it is covered, should do well so long as its extremities are displaced, and thus permitted to fret, irritate, and, perhaps, prick the muscles and other structures in contact with it. The sooner, indeed, the parts are restored to their natural relations, the more likely will they be to do well, and to escape the ill effects of inflammation. There are instances, however, where, as may be supposed, immediate interference might prove highly prejudicial, using the term immediate here with reference to the surgeon's first visit. The patient may have been neglected, or his attendant may have mistaken the nature of the case, and in this manner several days may have passed uselessly away. The limb is now found to be very much swollen, extremely painful, and intolerant of the slightest manipulation, nay, perhaps, in an erysipelatous condition. To make an elaborate examination under such circumstances would be very injudicious, as it could not fail to aggravate the morbid action, and, perhaps, urge on gangrene. The hand is withheld; the limb is placed in an easy position, and antiphlogistics, both local and constitutional, are freely plied; when action has sufficiently abated, but not until then, the proper examination is effected, and the diagnosis, if possible, established.

The mode of conducting the examination varies. In the upper extremity the surgeon will usually be able to get on without any assistance, but in fracture of the thigh and leg it is often necessary to make extension and counterextension while the parts are subjected to methodical manipulation. When there is marked displacement, the merest touch of the hand will generally suffice to detect the nature of the lesion; whereas, under opposite circumstances, the nicest digital exploration may be required. In general, it will be necessary to make pressure and counterpressure at the seat of the injury, and to rotate the portion of the limb below the fracture upon its axis. In this manner, especially if proper extension has been effected, the ends of the fragments, brought into close contact, may be made to yield the friction-sound, previously described, and at the same time display the full extent of their mobility. Another procedure is to grasp the two extremities of the suspected bone, and then, while the superior one is firmly held with the thumb and finger, to roll the inferior upon its axis. If both parts move together, the probability is that there is no fracture; whereas, if the lower move, and the upper remain stationary, there can be no doubt of the fact.

Mode of Repair.—A fracture is repaired precisely upon the same principle as a wound of the soft parts, the only difference being the superaddition of carbonate and phosphate of lime, or the earthy constituents of bone. In order, however, to understand the matter thoroughly, it is necessary to study it with reference to the situation and disposition of the ends of the fragments of the broken bone, as the rapidity and perfection of the cure are greatly influenced by the manner in which they are arranged and held together during the treatment. The more perfect the apposition is, the more complete, generally, other things being equal, will be the reunion. For practical purposes, the whole subject of repair may be considered as consisting of four stages.

The first stage, which, on an average, in the adult, extends from the first to the sixth or eighth day, is one altogether of preparation, in which nature clears away the rubbish, and places the ends of the fragments in a suitable condition for the process of repair, properly so called. The blood which was extravasated at the moment of the accident, at and around the seat of the fracture, is, in great degree, if not entirely, absorbed; the inflammatory products, especially the intermuscular, are also disposed of; the swelling subsides, the pain disappears, and there is no longer any tendency to spasmodic action, the muscles having become calm and quiet under their new relations. Any traumatic fever that may have been present will also be found to have vanished. Thus the part and system have happily passed through the preliminary stage of the reparative process.

If the parts be examined at the beginning of the second stage, it will be seen that the ends of the broken bone, as well as the periosteum, and the other soft parts in their immediate vicinity, are abnormally red and injected, and covered with a layer of embryonic cells, resembling very much, in color and consistence, pale currant jelly, or a thick solution of isinglass. It is usually most abundant upon the surface of the bone, and is often

sufficient to lift up the periosteum ; a considerable quantity is also generally seen between the periosteum and the muscles, and even among the muscles themselves, all these structures being more or less actively engaged in the process of repair. A similar tissue, but usually less abundant, is formed by the medulla of the central canal, the lining membrane of which is also in a state of inflammation, as is evinced by its discolored and injected condition. In the latter part of this stage, which lasts from the eighth to the sixteenth, eighteenth, or twentieth day, the granulation tissue, which differs in none of its properties from that which serves to unite a recent wound, becomes gradually more and more firm, until at length it assumes the consistence of a semisolid substance.

The third stage is characterized by still further changes in the consistence of the newly-formed tissue, and by its gradual conversion, first into fibro-cartilage, then into cartilage, and finally into bone ; or, more correctly speaking, cells are developed in the new substance, into which the osseous granules are deposited, the whole process bearing the closest possible resemblance to that which takes place in the formation of the original bone. It should, however, be stated that while the embryonic tissue which surrounds the surface of the broken bone is first transformed into cartilage, the mass of cells which result from the proliferation of the medulla, and which form the central plug, are converted into bone without the intervention of cartilaginous tissue. The period at which the osseous matter begins to be developed in the adult varies from the eighteenth to the twenty-fifth day, its appearance and progress being influenced by numerous local and constitutional causes, to be described under another head.

The ossific process proceeding in the way now described, two layers of bony matter are formed, one lying upon the outer surface of the ends of the fragments, the other within the medullary canal, each extending some distance beyond the seat of fracture, as is seen in fig. 422. To these two strata is confided the office of temporarily supporting the fragments, or of holding them together until their ends are permanently united by osseous substance ; a circumstance which does not, as a rule, take place until several months later. To this

Fig. 422.

Fractured Tibia, with new Bone beneath the Periosteum, and within the Medullary Canal.

new formation the older pathologists applied the term *callus*, in consideration of its hardness, which, when the process of repair is completed, is fully equal to that of the original bone, which it also closely resembles in its structure. From its office, the outer and inner callus, or that which invests the broken bone and lies in its medullary canal, is now universally known as the temporary or provisional callus, while that which is placed between the two ends of the bone, and thus serves to cement them together, is designated as the definitive or permanent callus. The temporary callus is, figuratively speaking, nature's splint, or the means which she employs to support the fractured bone until the continuity of the fragments is reëstablished by the deposit and organization of osseous matter between their extremities.

Callus, after having gone through its various stages of development and growth, is always much harder than normal bone, or the bone which it serves to unite. Its density, which often approaches that of ivory, is essentially due to a disproportionate increase of earthy matter. In natural bone the quantity of animal substance varies, on an average, from fifty-five to fifty-eight per cent., whereas in the callus of a broken bone it hardly reaches forty-five. The quantity of carbonate of lime is more than twice as great as in the natural state, and there is also a considerable increase in the amount of phosphate of lime. The composition, density, and strength of callus vary, of course, in different pieces of the skeleton, and in different conditions of the system, as it respects the age and health of the patient.

As the first stage in the reparative process is one of preparation, so the last is one of completion ; reunion having been effected, nature now busies herself in removing whatever is redundant or superfluous, thereby fitting both bone and muscle for the resumption of their respective functions. The provisional callus, having ceased to perform its office as a splint, is gradually brought under the influence of the absorbents, the more superficial portions being taken away first, and afterwards the more deep, until the broken bone regains not only its original form and volume, but also its pristine smoothness, all evi-

dence of fracture disappearing, excepting, perhaps, a little seam or ridge corresponding with the line of junction of the two fragments. While these changes are going forward upon the exterior of the bone, nature is busy at work in its interior, disposing of the provisional callus in that situation, and thus restoring the medullary cavity to its normal condition. This can occur, however, only when there has been perfect apposition of the ends of the fragments; for, when the reverse is the case, the new bone remains permanently in the canal, as is shown in fig. 423, from a specimen in my collection. Any

Fig. 423.
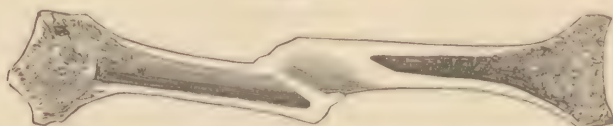
United Fracture, showing the Condition of the Medullary Canal.

fibrous, cartilaginous, or osseous matter that may have been formed between the periosteum and muscles, or among the muscles themselves, is likewise removed as a substance foreign to the part, and, therefore, useless, if not positively prejudicial.

It will thus be seen that the fate of the provisional callus is precisely similar to that of the plasma which is effused between the edges of a wound, both gradually disappearing, as soon as their service can be dispensed with, or as soon as the parts have acquired sufficient firmness to enable them to maintain their connection. The period required for effecting these changes in a broken bone varies from a few weeks to several months, according to the circumstances of the case, more especially the age and health of the patient, and the nature of the treatment.

Such is a brief account of the several changes which attend the repair of bone in the more simple forms of fracture, when the ends of the fragments are thoroughly maintained in their natural relations. Under such circumstances there is but little need of provisional callus; the ends of the fragments soon inflame, and unite almost by the first intention. But it is seldom that a patient is so fortunate; on the contrary, the fracture being generally oblique, is subject to more or less displacement, thus compelling nature to provide a temporary splint by the formation of provisional callus. I do not believe, however, as has recently been so much insisted upon, that there ever is an entire absence of this kind of callus, however intimately the ends of the bones may be in apposition with each other. To prove the truth of this remark, it is only necessary to examine the numerous specimens of fracture of the skull and other portions of the skeleton in our museums; they will conclusively demonstrate that even the most simple fracture, unaccompanied by the slightest displacement, is seldom repaired without the development of a certain quantity of osseous matter upon its surface. At the same time it must be admitted that the provisional callus, in such cases, is very small, and that it bears no proportion to the enormous amount of substance that is so often formed when the ends of the bone are separated from each other. Under the latter circumstances, nature labors under great disadvantage, and is, therefore, obliged to make extraordinary efforts to effect reunion, which she can do only by the development of a large provisional callus. From these facts, then, we may deduce the general law that the quantity of new bone is always, other things being equal, in proportion to the contact of the ends of the fragments, being small when this is very accurate, and more or less large when it is imperfect.

When the ends of the bones are not closely approximated, their edges are gradually

Fig. 424.
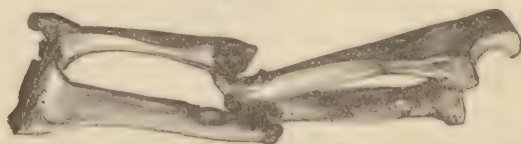
Appearance of the Ends of the Fragments in an old Ununited Fracture.

rounded off by the absorbents, the opening in the medullary canal is closed by a shell of new matter, as in fig. 424, and a large provisional callus is formed for the more secure

protection of the fracture. The whole process is one of time and labor, not of speed and ease, as in the former case. When the ends are completely separated, but opposite, or nearly opposite, to each other, they are generally united by a bridge of new bone, extending from one to the other, and ultimately affording sufficient strength for the support of the weight of the body upon the affected limb, as in fig. 425, from a specimen in my cabinet, representing the humerus of a turkey. Or, instead of this, especially in elderly subjects, the junction is effected by fibrous, fibro-ligamentous, or cartilaginous matter. Finally, osseous union is not impossible when the extremities of the fragments overlap each other to an extent even of several inches, provided they are in contact; for in this case inflammation is established in the contiguous surfaces, followed, after a long time, by a large permanent callus. We see many curious specimens illustrative of this fact, although, in general, the union is ligamentous.

Fig. 425.

Fracture of the Arm-bone of a Turkey.

There are certain pieces of the skeleton in which in fracture provisional callus seldom, if ever, forms. Of this description are the olecranon, acromion, patella, and neck of the femur. Instead of uniting by osseous matter, as the other bones do, the cure is generally effected through the medium of fibrous, ligamentous, or cartilaginous substance, and the consequence is that the part commonly remains weak ever afterwards. Various causes conspire to produce this result, as the difficulty of maintaining the contact of the broken surfaces, and the inordinate secretion of synovial fluid, which, mingling with the effused plasma, thus impairs its vitality, and renders it unfit to become the nidus of bony deposit; but the most efficient one of all is the want of nourishment of the smaller fragment produced by the laceration of its nutrient vessels. Thus, in intracapsular fracture of the femur, the only connection between the upper fragment and the pelvis is by the round ligament, the arteries of which are altogether unequal to its proper support.

Treatment.—The leading indications in the treatment of fracture are to procure reunion and to prevent deformity. Before the manner of fulfilling these indications is discussed, it is proper to lay down certain rules for the transportation of the patient, and the mode of preparing his bed.

Fractures are often received by persons at a considerable distance from their homes, either on the road, in the field, or at some secluded building. This renders it necessary to carry them to their own houses or to some hospital, in order that they may undergo the proper treatment. In fractures of the superior extremity, clavicle, scapula, or ribs, the requisite dressings may be applied at once; or, if this is not convenient, the patient may either walk or ride, the suffering limb being supported in a sling; or, in the case of a broken rib, the body may be swathed with a long towel. It is only, as a general rule, in fractures of the inferior extremity, spine, or pelvis, that the patient will require to be carried, and the best way of effecting this, if the distance is not too great, is to place him upon a narrow door, a long shutter, or two pieces of board, supported by two cross-pieces, the ends of which are intrusted to four assistants, a pillow and comfort having previously been put under the patient's head and body. Or, instead of this, the transportation may be conducted upon an easy furniture-car, provided with a good mattress, and drawn slowly along in order to avoid jolting. Whatever mode be adopted, the limb should be temporarily splinted, and placed in as comfortable a position as possible, an intelligent person sitting by the patient's side, and rendering such aid as may be required on the way. In carrying him to his chamber, four assistants will generally be necessary, two to support the body, which they do by crossing their arms behind the trunk and interlocking their hands, and two for the lower extremities, the surgeon himself taking charge of the broken one.

It may be assumed as an axiom in surgery that no man with a broken thigh or leg can be treated successfully without the advantages of a suitable bed. Prompt attention should, therefore, always be given to this matter, in order that no injurious delay may arise. When we reflect upon the fact that in fractures of the lower limbs the patient is often compelled to remain in the recumbent posture for weeks together, and how difficult it is, in most cases, to maintain the requisite extension and counterextension, the force of this injunction cannot fail to be perceived in its true light. The essentials of a good fracture-bed are, first, firm, stout slats, instead of a cord or sacking bottom; secondly, a well-

constructed mattress of hair, moss, or cotton; and, thirdly, a hole in the mattress, opposite the buttocks, for the easy relief of the bowels, the opening being closed by a door of similar manufacture, and furnished with hinges and other appliances. If long confinement in one posture is necessary, or if the patient has been worn out by previous disease, an air-mattress may be required, in order to prevent bed-sores. If a sheet be used, the edges should be carefully pinned to the sides of the mattress, otherwise it will soon become rumpled, and a source of more or less annoyance, if not of great suffering.

It has been a much mooted question whether, as a general principle, a fracture should be set as soon as possible after its occurrence, or whether time should be allowed for the subsidence of the resulting inflammation. It appears singular that upon a subject so clear as this there should be any difference of opinion. It certainly requires no great knowledge of the nature of accidents to discover why such cases should receive the earliest possible attention; so long as the ends of the fragments are permitted to remain apart, their tendency inevitably must be to excite spasm and inflammation, thereby increasing the suffering of the patient and retarding his cure. Of this fact there can be no doubt, and, therefore, my plan is to treat every case of the kind as early as possible with the bandage and splint; applied, of course, not firmly, but gently and cautiously, simply with a view of giving support to the parts, and thus preventing further mischief from the sharp and projecting ends of the broken bone. It is difficult to imagine an instance to which such treatment would not be adapted. It might as well be expected that a man's limb would do well if it had a thorn imbedded in its muscles, as that it would be comfortable with two pieces of bone sticking in them. It is absurdity to think it could be otherwise.

When, in consequence of excessive inflammation, a fracture cannot be set at once, the limb should be maintained perfectly at rest, in the easiest possible position, and the parts kept constantly wet with lotions of lead and laudanum until the case admits of the application of the permanent dressing. This practice is nowhere more necessary than in fractures affecting the joints, which are always followed by more or less copious effusion of synovial fluid. To get rid of such fluid as soon as possible is a cardinal rule of treatment; and certainly no sensible surgeon would use any tight dressing so long as there is any considerable swelling of the soft structures.

Apparatus.—Before an attempt be made to set the fracture, it is necessary to provide the requisite apparatus for effecting its maintenance. The means which are employed for this purpose are splints, cushions, bandages, and adhesive strips.

Splints are made of various materials, as wood, trunk-board, leather, felt, gutta percha, tin, wire, and iron, according to the nature of the fracture, or the fancy, whim, or caprice of the practitioner. In fracture of the thigh and leg, especially in that form which requires permanent extension and counterextension, the best article is wood. In fracture of the superior extremity, particularly of the humerus and of the bones of the forearm, splints made of trunk-board generally fulfil every indication, as by a little manipulation, after immersion in hot water, they may easily be moulded to the form of the limb. A piece of thick pasteboard affords a good support to a broken jaw or finger. Unoiled sole leather, gutta percha, and felt, the latter being rendered stiff by gum shellac, make excellent splints, which are often used with much satisfaction in fractures both of the upper and lower extremities. Previously to applying them, they must be softened in hot water, the sharp angles and edges having been pared off with a knife. The tin case I have employed a great deal, especially in fracture of the humerus at the elbow, and of the tibia at the ankle, ever since I entered the profession. Iron splints, in the form of the double inclined plane, are sometimes used; and very good splints may be made of light wire and of perforated zinc. For fractures of the bones of the hand and fingers, carved splints are very serviceable.

An excellent splint may be made by filling the meshes of a piece of linen, muslin, or canton flannel with a thick solution of plaster of Paris in water, and then doubling the cloth upon itself as many times as may be requisite to obtain the proper strength, when it is immediately secured to the limb with a roller. The advantages of this apparatus are that it dries in a few minutes, forming thus almost instantaneously a firm, stiff shell for the broken limb, perfectly adapted to its inequalities, exceedingly light, indisposed to absorb discharges, and admitting of easy application and removal. The plaster splint was first employed in this country by Professor James L. Little, by whom it was introduced into the New York Hospital as early as 1861. It is rapidly coming into general use.

Felt splints, adapted to the different regions of the body, and put up in portable cases, have of late years been a good deal employed; they are very light and flexible, are not affected by cold or warm water-dressings, and are easily moulded to every inequality of the surface of the parts to which they are applied.

Fracture *cushions* are generally made in the form of small bags, stuffed with bran, fine chaff, cotton, wool, hair, moss, or any other soft material. They are designed to fill up the inequalities between the splints and the limb, and must necessarily vary in shape, length, breadth, and thickness, according to the exigencies of each particular case. Instead of cushions, simple pads or compresses are often used, especially in fractures of the superior extremities. For enveloping short splints, calico, muslin, or old flannel is employed; or, what I always prefer, glazed wadding. The same article or batting answers admirably for filling up the inequalities between the short splints and the affected limb. Bags filled with sand are sometimes very convenient and useful, especially in fractures of the leg and thigh. Stretched along the sides of the limb, they keep up steady, equable pressure, well calculated to prevent displacement of the fragments.

The fracture *bandage* is made of coarse linen or muslin, of sufficient strength to answer the purpose for which it is intended. Nothing is worse, or more likely to cause annoyance, than a thin, flimsy bandage. If the material is new, it must be washed before it is used, to rid it of its glazing, and the selvage is torn off to prevent it from exciting irritation, or producing welts in the skin. The bandage most commonly used is the ordinary single-headed roller, of a length and breadth suitable to the affected limb or part of the body to which it is to be applied. In fractures of the leg and thigh, especially complicated ones, the bandage of Scultetus may often be advantageously employed, as it can be easily undone and reapplied without any disturbance to the limb. It consists of numerous strips of the ordinary roller, of equal or unequal length, according to the size and shape of the affected parts, applied in such a manner that one overlaps another nearly one-half.

Too much caution cannot be observed in the use of the bandage in the treatment of fractures. It is an agent for good or for evil; for good, if applied properly; for evil, if applied improperly. Its object is twofold; first, to afford uniform compression of the limb, thereby preventing swelling and spasm; and, secondly, to retain the necessary apparatus. The application is always begun at the distal portion of the limb, and continued upwards some distance beyond the seat of the injury, care being taken not to interrupt the circulation, or, to inflict other mischief. If it be too slack to support the parts in a proper and uniform manner, it will be useless; if too tense, it will give rise to severe inflammation, swelling, and even gangrene. For the want of this precaution, many limbs are lost, and a still greater number rendered permanently useless.

The application of the roller to the surface of the skin in the treatment of fractures, has at the present day many opponents, on the ground that, when thus employed, it is liable, by its pressure, to embarrass the circulation, and predispose to the occurrence of gangrene. It is alleged that it is particularly objectionable when applied high up to the forearm when the limb is greatly flexed, or placed nearly at a right angle with the arm; or when, under similar circumstances, it is applied to the foot and leg. Any thing is liable to abuse, and it is certain that a roller, if improperly applied, may do a great deal of harm; a circumstance against which a judicious surgeon always carefully guards. If he has not sufficient confidence in his ability to use the roller, or the circumstances for its employment are inauspicious, the only rational plan is to dispense with its application as a covering for the skin.

Adhesive plaster, cut into suitable strips, is now universally employed in this country, as a means of making extension, in the treatment of fractures of the lower extremity, and nothing, certainly, could generally answer a better purpose. To this plan of treatment I called special attention, in my Treatise on the Diseases of the Bones and Joints, published in 1830, having a short time previously witnessed its good effects in the practice of the late Dr. Joseph K. Swift, of Easton, in a case of very oblique fracture of both bones of the leg, complicated with so much injury of the soft parts as to interfere effectually with the use of the garter and other extending bands. The man had suffered a great deal of pain, until his patience was almost exhausted, when trial was made with adhesive strips, carried along the sides of the limb towards the knee, their free extremities being tied below the foot, to the transverse block connecting the two splints. Great comfort was at once experienced, and the case progressed favorably from that time forward. Soon after, I had occasion to use adhesive strips in a case of my own, with results equally gratifying: I subsequently extended the practice with great advantage to the treatment of fractures of the clavicle, ribs, olecranon, and patella, as well as of the thigh and leg. Valuable papers have been published on this mode of management by Ellerslie Wallace, David Gilbert, John Neill, Josiah Crosby, and others. In a short article in the Philadelphia Medical Examiner for 1852, I also called attention to the subject, giving very

briefly the results of my experience up to that period. The importance of this agent, for the purposes here referred to, will be fully pointed out under the head of special fractures.

Coaptation and Dressing.—Everything having thus been provided, and the requisite number of assistants obtained, the surgeon proceeds to restore the broken pieces to their original situation; or, to use a common expression, to set the fracture. This may be done either by simple manipulation, or by pressure and counterpressure, or by this means aided by extension and counterextension. The former will usually suffice in fracture of the upper extremity, the jaw, and nose, while the latter will generally be required in fracture of the thigh and leg; in either case, the affected limb should be held as quietly as possible, not only during the adjustment of the fragments, but also during the application of the dressings. It need hardly be observed that these manipulations should be conducted in the most gentle manner, with an eye both to present comfort and future consequences. There is no department of surgery where the humane practitioner may exhibit his skill and sympathy to greater advantage than in this, or where his conduct will be more closely watched and commented upon than upon such an occasion.

There are several causes which may seriously interfere with, and sometimes even entirely prevent, the reduction of a fracture. Of these one is muscular contraction, induced by the irritated condition of their fibres, which, however, is generally easily overcome with the aid of an anæsthetic. Occasionally the obstacle is some foreign substance, as a piece of bone or a portion of muscle, accidentally interposed between the ends of the broken bone. Now and then the difficulty depends upon the presence of coagulated blood. The most common cause, however, of all is the shape of the extremities of the fragments. If these be denticulated, very sharp, notched, or uncommonly oblique, accurate adjustment and maintenance will be extremely difficult. In extensive comminution, as in certain multiple fractures, the obstacle to reduction is often very great, if not positively insurmountable, owing to the manner in which the fragments are wedged into each other and into the surrounding structures.

Extension and counterextension are always necessary in oblique fractures of the extremities, attended with displacement. By the term extension is understood the force which is required to draw the upper end of the lower fragment to a level with the lower end of the upper fragment, in order to place them in their natural relations; by counterextension, on the contrary, is implied the resistance which is employed to prevent the limb, or even the body, from being dragged along by the extending power. The extension is generally made upon that part of the limb which is articulated with the lower piece, and the counterextension upon that which is articulated with the upper. Thus, for example, in fracture of the shafts of the bones of the forearm, the extending power acts upon the hand, and the counterextending power upon the arm, while in fracture of the body of the humerus the two forces are respectively exerted upon the forearm and the chest; and so in regard to fracture of the inferior extremity. When but little muscular resistance is anticipated, as in a child or feeble person, the extension and counterextension may be applied directly to the two fragments, but at as great a distance from the seat of the injury as practicable. On the whole, however, the former method is decidedly preferable, as it is much less likely to irritate and worry the muscles.

In reducing a fracture, the parts must be put in the most favorable position for relaxing the muscles, and the extending forces applied in as slow and gradual a manner as possible. If the limb is suddenly pulled, or stretched by fits and starts, the muscles concerned in effecting and maintaining the displacement will inevitably be thrown into violent spasmodic contraction, thus not only causing pain, but, perhaps, severe injury to the soft structures, if not actually frustrating our intention. The degree of force used in making extension must vary according to the amount and character of the displacement, and the number and power of the muscles engaged in producing it; in all cases it should be sufficient to remove the shortening of the limb, or, what is the same thing, to restore it to its normal length, and to surmount every obstacle that opposes the reduction. The extension is always begun in the direction of the lower fragment, and is afterwards continued in that of the injured bone, until the object is fully attained. The ends of the fragments being now pressed into their natural situation, the fractured limb is immovably fixed by splints, every hollow between them and the skin being filled with cotton, to ward off pressure. Any spasmodic action of the muscles that may interfere with the reduction of a fractured bone is generally very readily counteracted by a few deep whiffs of chloroform; or, even without the aid of this agent, simply by the compression of the main artery of the limb, thereby lessening the flow of blood to the parts.

In fractures of the superior extremity, the hand and forearm are suspended in a sling,

and the patient may walk about and attend to business; but when the thigh or leg is involved, he must remain in bed until the ends of the broken pieces are completely consolidated, or until he has so far recovered that he can use the immovable dressing and exercise in the open air upon crutches. During his confinement, the limb is placed in the most favorable manner for relaxing and resting the muscles which pass over the fracture; for this purpose it should be put in the extended position, and be well secured with apparatus designed to maintain permanent extension and counterextension. In some cases the limb is placed in the semiflexed position, over a double inclined plane, but this will seldom be necessary or proper, except, perhaps, in fracture of the upper part of the body of the thigh-bone, attended with great and obstinate displacement of the superior fragment, in consequence of the joint action of the psoas and iliac muscles. In transverse fracture of the patella, the thigh and leg are sometimes placed over a single inclined plane, the foot being considerably elevated above the level of the trunk.

The treatment of fractures of the lower extremities is now very generally conducted in this country by extension with adhesive strips, weight and pulley, inasmuch as it is not only very simple but very effective. The limb is supported by appropriate splints, long and short, by the immovable bandage, or by sand-bags, as necessity or convenience may dictate. A short, narrow piece of wood is placed between the adhesive strips below the sole of the foot for the attachment of the cord connected with the pulley. The weight, composed of shot, iron, or other material, varies, on an average, from five to fifteen pounds, according to the age of the patient, the obliquity of the fracture, and the amount of muscular resistance. The necessary counterextension may readily be made by raising the foot of the bedstead. In paralysis of the limb but little weight will be required, and in no event should it be so great as to cause uneasiness or suffering.

When adhesive strips and the immovable apparatus are used, it will save the patient much suffering and the surgeon great trouble if the limb be well shaved previously to their application. Indeed, it is hardly possible to pay too much attention to every little detail tending to promote comfort and speedy recovery.

A fracture occurring in an ankylosed limb requires no special treatment beyond the adaptation of peculiar splints, to meet the exigencies of the particular case. A similar remark applies to fracture of the bones of the stump of an amputated limb, and to fracture of a limb which is the seat of an old, unreduced, or irreducible dislocation.

After-treatment.—The fracture having been reduced and dressed, the patient is carefully watched, in order that he may be safely conducted through his long and arduous confinement. His diet for the first few days should be light and cooling, and the bowels should not be disturbed for the better part of a week, unless it is absolutely necessary, in which event some mild aperient, as a dose of castor oil, Rochelle salt, or citrate of magnesium, may be administered. If fever supervene, antimonial and saline preparations are to be freely used, aided, if the symptoms are urgent, and the patient is plethoric, by venesection, and aconite or veratrum viride, although general bleeding will rarely be called for. Action having subsided, the patient gradually resumes his accustomed diet, being still careful, however, to err rather on the side of abstinence than on that of excess. Pain is relieved by anodynes; the bladder, if necessary, by the catheter.

During all this time the fractured limb is carefully watched, the patient being visited for a while at least once a day, or, if the case is at all troublesome, even twice a day, until all danger of mischief is over. If considerable pain and swelling exist, it will be well to remove the dressings at the expiration of the first twenty-four hours, otherwise they may be retained for a longer time. While I am an advocate for the careful supervision of the dressings. I am opposed to frequent change, as it tends to injure the ends of the broken bone, and to impede the reparative process. If the first dressings have been applied lightly, as they always should be, and the parts are well seen to afterwards, it is hardly possible for the patient to do badly. The great danger, in nearly all cases, so far as the safety of the limb is concerned, is during the first week; that passed, there is seldom any risk.

In most fractures of the long bones there is more or less spasm, jerking, or twitching of the limb, coming on within the first ten or twelve hours after the accident, much to the discomfort both of the part and system. This is owing partly to the pressure and irritation produced by the ends of the fragments, partly to the inflammation of the muscles, and is, in general, easily remedied by the rectification of the displacement, aided by warm applications and a full anodyne, either alone or in union with camphor and tartar emetic. Relief often follows in a peculiarly happy manner the hypodermic introduction of morphia. The worst forms of this complaint are met with in nervous, irritable persons, in whom it

occasionally persists with great obstinacy, despite our remedies, for a number of days, much to the annoyance of all concerned.

In fractures of the thigh and leg, especially the latter, the limb must be carefully protected from the pressure of the bedclothes, by means of a contrivance, such as that exhibited in fig. 426. It consists of two pieces of wood connected by several semicircles of hoop, or wire, attached by a longitudinal piece.

Fig. 426.

Wire Rack for Fracture of the Leg.

In fracture of the superior extremity, the patient is often able to walk about immediately after the accident, taking outdoor exercise, and, perhaps, even attending to business. But it is very different when he has a broken leg or thigh. Here, as a general rule, he is obliged to remain recumbent, often for a most unreasonable time, until, it may be, he is bedridden, and worn out with suffering. This is wrong. Such a case demands an immediate change of treatment. The starched bandage is substituted for the previous dressings, and the patient is sent out into the open air upon crutches. Prompt amendment follows; the general health rapidly improves, and the process of repair, having received a new impulse, steadily advances to completion.

As fractures are constantly liable to be followed by weakness and stiffness of the limb, the rule is to move the joint nearest the injury as soon as the union is sufficiently advanced to preclude the possibility of displacing the fragments or interrupting the consolidating process. This constitutes what is called passive motion, a most important element in the management of this class of lesions. It should not be commenced, as a general rule, before the end of the third week, after which it should be repeated once a day, or every other day, according to circumstances; it should be very gentle at first, and be gradually increased until the limb has completely regained its normal functions. During its performance the parts are properly supported by assistants, and the dressings are reapplied the moment it is over. The restoration of lost function will be greatly promoted by frequent ablutions with warm water and soap, followed by systematic massage and frictions with some sorbefacient lotion, as spirit of camphor, soap liniment, or weak solutions of iodine.

As soon as the callus has acquired sufficient firmness to sustain the ends of the broken bone, the splints and bandages are either discontinued, or applied more loosely, the object now being merely to keep the parts at rest until the union is perfectly consolidated. In fractures of the inferior extremity, some days should usually elapse before the patient is allowed to rise, and no weight should be thrown upon the affected limb under a fortnight or three weeks; the new bone is still weak, no definitive callus has yet formed, and the individual, awkward from long disuse of his joints, is liable to fall from the slightest accident. These precautions are so extremely important that they should always receive the most scrupulous attention.

Immovable Dressing.—The treatment of fractures by the immovable dressing is now almost universally employed in this and other countries, either alone or in union with other means. The plan is applicable to fractures not only of the extremities but also to those of the trunk, especially of the clavicle, scapula, ribs, and pelvis, and, if properly carried out, is a time-saving expedient, at the same time that it adds greatly to the patient's comfort and the ultimate success of the treatment. To Seutin, of Brussels, Velpeau, of Paris, and Dr. Van Buren, of New York, the profession is mainly indebted for the introduction of this valuable method of treatment. It is not, of course, applicable to all cases; but if proper care and judgment be exercised in their selection, there are few in which, in some stage or other of their progress, it may not be advantageously employed. There are many excellent surgeons, prominently among them Yandell and Cowling, of Kentucky, Erichsen and Croft, of England, and Von Langenbeck, of Germany, who are in the habit of applying this dressing, as a rule, immediately after the occurrence of the fracture, whether simple or complicated, and such a treatment has certainly its advantages, especially in hospital practice. But is it equally safe in private practice? In public institutions, where the surgeon is an autocrat in his wards, where he has complete control over his patients, and where the resident physicians and nurses exercise a constant surveillance, there can be no objection to such a procedure; for, if anything untoward arises, immediate relief is at hand. But it is widely different in private practice, especially when the patient and the professional attendant are at a considerable distance from each other; if, in such cases, the dressing is too tight, or improperly applied, great suffering, violent inflammation, or even gangrene may occur, before it can be removed and the evil remedied. For these reasons, I am myself averse to the early

use of the immovable apparatus, convinced that, as a rule, the safest plan is to wait until the resulting inflammation and swelling, of which, even in the more simple cases, there must generally be more or less, has completely subsided. From five to ten days, according to the amount of injury, should, on an average, in my opinion, be allowed to pass before a fractured extremity is put up in such a dressing; employed earlier, it may induce undue compression, and thus compel removal. I would, then, have an eye to time and circumstances; avoiding premature interference, on the one hand, and too long delay, on the other.

The immovable dressing may be prepared with various substances, all of them possessing more or less, although not equal, merit. Cowper, an old English surgeon, employed compresses and bandages, saturated with a mixture of the albumen of eggs and wheat flour, which was replaced by Lawrence by powdered chalk. Seutin was the first to recommend starch; Velpeau used dextrine; Smee prefers gum arabic and whiting; gum shellac and glue have their advocates; the plaster of Paris dressing has been justly lauded, and of late much has been said in commendation of paraffin, silicate of sodium, and silicate of potassium. All these various articles possess the advantage of cheapness, and of being easily prepared, applied, and removed, as well as being always easily procurable.

Of all these substances, the most valuable and reliable are plaster of Paris, silicate of sodium or potassium, and paraffin. The starch bandage has become obsolete; and dextrine is seldom, if ever, employed by the surgeons of this country.

Plaster of Paris was originally recommended as a scientific dressing in the treatment of fractures by Professor Kluge, of Berlin, in 1829, although it had been previously used for a similar purpose by Hendrikes, of Gröningen. The bandage is prepared by rubbing the dry plaster, of the finest quality, and freshly calcined, thoroughly into the meshes of a thick, coarse muslin or crinoline roller, which, if not required for immediate use, is loosely wound, and kept in a dry place until needed, when it is soaked for a few minutes in cold water. The limb, carefully enveloped in flannel, wadding, or old linen, is surrounded with the bandage in the usual manner, from three to four layers generally sufficing for the purpose. If, when the application is completed, the dressing is not firm enough, a mixture of plaster and cold water, of cream-like consistence, may be rubbed on with the fingers until the surface presents a smoothly polished appearance. Care, however, must be taken not to apply it too freely, otherwise it will make the dressing too brittle for comfort and usefulness. No splints need be employed, as any additional support that may be required may readily be supplied by folded cloths, saturated with the plaster, and stretched along the limb. It should be remembered that a solution of salt in warm water promotes the setting of the plaster, while the addition of a small quantity of glue or stale beer retards it. The great advantages of this dressing are, the rapidity with which it dries and adapts itself to the parts, and the fact that it forms an unusually firm, hard casing, which permits the limb to be handled and moved with great ease during any transportation that may be necessary to place the patient in more suitable quarters. A layer of varnish, applied the day after the dressing, will prevent the plaster from chipping.

It is very important that the plaster, in preparing the bandage, should be rubbed as thoroughly and equably as possible into its meshes. This can seldom be done with the hand. To meet this contingency, Dr. Marcy, of Boston, has devised an apparatus, represented in fig. 427, which distributes the powder uniformly upon both sides of the cloth by drawing it from below upwards through the dry plaster.

The *Bavarian dressing* for fractures, so extensively used during the Franco-German war, is an easy and effectual mode of applying plaster of Paris. When employed for frac-

Fig. 427.
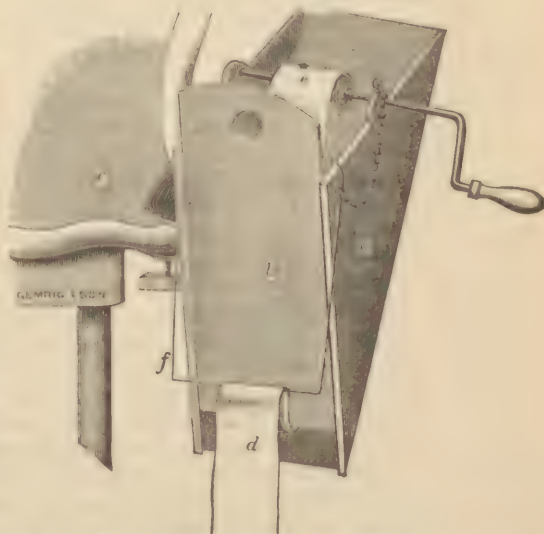
Marcy's Plaster Bandage Roller. *a*, the part of the apparatus secured to the table *c*; *b*, the slide, which, when pushed down, holds the plaster on both sides of the bandage *d*, which is rolled up at *e*.

tures of the leg, two pieces of flannel, long enough to extend from the ham nearly to the toes, are stitched together behind, so that the seam shall correspond to the middle line as far as the heel, beyond which both layers are divided in the same line for adaptation to the foot. The sides of the layer next the skin are firmly sewed together in front of the limb and along the sole and instep, when the plaster is thickly spread over the entire casing, and covered by the outer layer of flannel, the flaps of which are then secured with stitches in front. When the plaster is set, the stitches are cut, the super-fluous edges of the splint are trimmed off, and the apparatus is secured by a bandage or by tapes passed through eyelets. The seam behind serves as a hinge, through which the dressing may be removed and readjusted with the utmost facility. In fig. 428, from Bryant, the limb is seen to be supported by a bandage carried through the superfluous edges of the flannel, for greater convenience of application.

Fig. 428.

Bavarian Splint. a, first layer of flannel applied to the limb; b, second layer about to be applied.

The *silicate of sodium* or potassium in saturated solution, applied with a stout brush, constitutes what is called the glass dressing, as it forms, when well rubbed into the meshes of a wet roller, a firm, immovable apparatus, in no wise inferior to that of plaster of Paris. Indeed, in certain situations, as in fractures of the clavicle, scapula, and ribs, it deserves a decided preference. The glass dressing dries very rapidly, does not irritate the skin, is easily procured, and is, withal, very cheap. The under dressing is the same as in the plaster dressing. From three to five layers of bandage are, on an average, necessary to impart the requisite amount of stiffness; and occasionally the surgeon is compelled to interpose a binder's board, or some other thin substance, to afford additional support.

An excellent fracture dressing may be made of *paraffin*. After being thoroughly melted, this substance is partially cooled, to render it more viscid, when it is rubbed freely into the meshes of the bandage with a coarse paint-brush, forming thus a very neat, light dressing, perfectly impermeable to water, pus, and other fluids, and, therefore, admirably adapted to the treatment of compound fractures, and also to simple fractures in young children, in whom the ordinary contrivances soon become soiled with the natural excretions.

The *glue dressing*, also a very excellent one, is prepared by rubbing into the bandage warm glue, diluted immediately before it is used with a fifth part of its bulk of alcohol or a small quantity of oxide of zinc, to promote desiccation. The mixture, applied in the usual manner, soon begins to harden, although it does not become perfectly dry under several hours. From two to four layers of bandage, with one of wadding next to the limb, usually suffice. If additional strength be required, fresh strips of linen may be glued on without changing the original dressing, which generally retains its place until the fracture is consolidated.

The apparatus of Smee, known as the *moulding tablet*, forms a very good dressing, nowise inferior to the stiff bandage, and but little, if any, more expensive. It consists of two layers of coarse, old sheeting, cemented together by means of a thick paste made by rubbing very finely powdered whiting with mucilage of gum arabic. The sheeting soon dries, without shrinking, into a hard, firm substance, which, with the aid of a sponge and hot water, may afterwards be accurately moulded to the fractured limb, and worn with great comfort and efficiency.

Tripolith was suggested, in 1880, by Von Langenbeck, as a substitute for plaster of Paris in the treatment of fractures, on the ground of its making a lighter dressing, and one that would dry more rapidly, from three to five minutes generally sufficing to render it perfectly solid. It has been asserted that it does not readily absorb moisture, and that it undergoes no change from contact with water; a statement which, however, is not strictly correct. Dr. Samuel N. Nelson, of Boston, who has made some trials with it, considers it utterly untrustworthy. The dressing is prepared and used in the same manner as the plaster dressing. Tripolith consists mainly of calcium and silicium with a small quantity of protoxide of iron.

The *egg paste*, as it is termed, makes, if properly used, a very firm dressing, admirably adapted to cases requiring the immovable apparatus. It is prepared by mixing the white of eggs with a sufficient quantity of flour, until it assumes the consistence of a thick solu-

tion of gum arabic, when it is rubbed into the meshes of the roller previously wrung out of water. When dry, the bandage forms a firm, hard case.

Whatever immovable dressing be used, it is indispensably necessary to keep up extension and counterextension by assistants, or other suitable means, until the apparatus is sufficiently solidified to prevent displacement of the fragments. In some cases, as when there is inordinate tendency to displacement, the extension and counterextension may be obliged to be continued for a considerable length of time, if, indeed, not permanently, or until the process of reunion is completed.

When the dressing, of whatever material it is composed, is perfectly dry, it forms an immovable case for the limb, making equable and uniform pressure throughout, and maintaining the fragments of the broken bone accurately in apposition. If the parts feel entirely comfortable, the patient may now sit up in bed or on a chair, or he may even walk about on crutches, the leg being properly supported in a sling. Generally, however, it will be found that there is for a day or two a sense of soreness, with, perhaps, some degree of throbbing, inviting recumbency rather than the erect post-

Fig. 429.

Seutin's Scissors.

ure. If the apparatus causes marked discomfort, by bearing unequally upon any portion of the limb, or if throbbing and swelling arise, it must immediately be removed. For this purpose it should be slit up with Seutin's scissors, represented in fig. 429, or with a shoemaker's knife, or a Hey's saw, the tract to be cut in the dressing being previously softened with hot water applied with a sponge. The limb being properly supported by an assistant, the hardened shell is gently peeled off from its surface, which is then carefully sponged with alcohol and laudanum, or spirit of camphor, when the apparatus

Fig. 430.
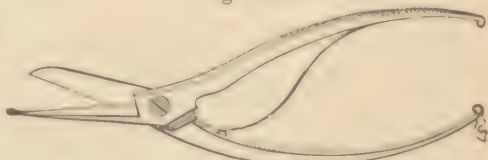
Fig. 431.

Fracture of the Thigh, done up in Immovable Dressing.
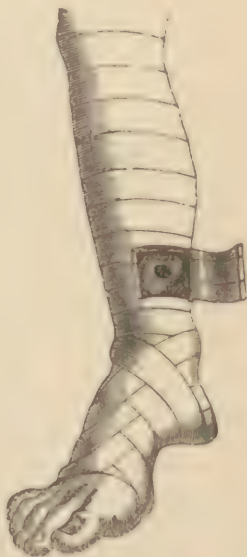
Dressing in Compound Fracture of the Leg.

is immediately reapplied with the aid of a roller; or, instead of this, eyelet holes may be inserted, at suitable distances, in the border of the dressing, and retention effected with pieces of narrow tape. Thus, by simply opening the dressing from time to time, an opportunity is afforded of inspecting the limb, and ascertaining its precise condition, not only at the seat of fracture, but everywhere else. When the patient is able to move about

on crutches, the limb should be carefully supported in a sling, arranged in the manner represented in fig. 430.

When the fracture is seated high up in a limb, the apparatus should extend a short distance above it, as it is a matter of great moment to keep the joint in as passive a condition as possible. In compound fracture, attended with discharge, a hole should be cut in the apparatus opposite the wound, so as to admit of the necessary drainage, as shown in fig. 431.

Great care should be taken that the edges of the splints do not produce any injurious compression; to obviate this, it is usually recommended that they should be torn instead of being cut, it being alleged that, when thus treated, they will be much less likely to create mischief. My experience, however, is that this is not the fact, and I, therefore, invariably bevel the inner edges with a stout knife, thereby effectually preventing all risk of this kind.

It is impossible, also, to bestow too much attention upon the bandage; the care or negligence with which this is applied will make all the difference in the result, both as it respects the patient's comfort and the character of the cure.

Shortening of the Limbs after Fractures.—I think I am not wrong when I assert that more or less shortening of the limb in fractures of the lower extremity is almost universal, no matter how carefully, or in what manner, the treatment may be conducted. This remark, however, applies solely to oblique fractures, and has no relevancy whatever to transverse fractures which, as a rule, if not in every case, if properly managed, ought to get well without any deformity whatever of this kind. The amount of shortening will vary, of course, with the particular circumstances of each case, as the degree of obliquity of the fracture, the nature of the treatment, and, above all, the coöperation of the patient, on an average from the eighth of an inch to half an inch. In many cases it will necessarily exceed half an inch, and it may even reach twice that extent without in the slightest degree impairing the usefulness of the affected limb, unless it should naturally be considerably shorter than the sound one. In exceptional cases there may be an entire absence of shortening; and it should be borne in mind that in hospital practice, where the patient is always more fully under the control of the surgeon, and where the means and appliances for treatment are better adapted to the object, there is less excuse for the occurrence of shortening and deformity than in private practice, where the reverse is so often the case. The treatment of fractures of the humerus, however carefully conducted, is very liable to be followed by more or less shortening; in fractures of the shafts of the bones of the forearm shortening is uncommon.

Shortening in fractures of the bones of the lower extremity is often due to the premature removal of the extending apparatus and to the too early use of the limb. The weight of the body being thus thrown upon the broken bone, before the callus is sufficiently hardened, forces the ends of the fragments apart, and thereby occasions not only shortening but more or less lateral deformity; in fact, the connecting material may, in this way, even be completely destroyed.

The subject of the symmetry in the length of the extremities, upper as well as lower, is one that intimately connects itself with the present inquiry, and is of great interest not only in its practical bearings but also in a medico-legal point of view, as cases attended with marked shortening of the limb after the cure of fractures are not unfrequently carried into court for the recovery of damages, on the ground of alleged malpractice. Fortunately, thanks to the labors of a number of recent zealous investigators, this matter is now fully settled, and while I cannot agree with some of them, as for example, Dr. William Hunt, of this city, who has greatly interested himself in the study of this subject, and thrown valuable light upon it, that asymmetry of the limbs exists as a rule, I am prepared to affirm that it is present in very many, if not indeed, in a majority, of cases. The attempts to solve this question were begun at the Pennsylvania Hospital, in 1875, at the instance of Dr. Thomas G. Morton, by Dr. William C. Cox, one of the resident physicians, who found, in 54 cases, the right lower limb the longer in 23, and the left in 25, 6 presenting no difference. In the 48 cases the variations ranged from $\frac{1}{8}$ to $\frac{3}{4}$ of an inch. It is proper to observe that these observations were made with a tape extended from the anterior superior spinous process of the ilium to the internal malleolus, while the subject lay flat upon his back, upon a hard surface. Similar results were obtained two years later by Dr. J. S. Wright, of Brooklyn. Finally, in 1879, as if to remove all doubt upon the subject, Dr. Morton, in an examination of 513 boys from eight to eighteen years of age, found inequality in the lower limbs in 272, while in 241 there was no appreciable difference. In 91 the difference was $\frac{1}{8}$ of an inch; in 100, $\frac{1}{4}$; in 41, $\frac{3}{8}$; in 22, $\frac{1}{2}$; in 12, $\frac{5}{8}$; in 2, $\frac{3}{4}$; in 2, $1\frac{1}{8}$;

and in 1, 1⅜. Of the 272 cases of inequality the right limb was the longer in 198, and the left in 74.

These measurements tally well with similar ones made on the skeleton. Thus, in eight examinations made by Dr. John B. Roberts, of this city, the difference in the length of the lower extremities ranged from one-eight to three-eighths of an inch; the tape being extended from the top of the femur to the internal malleolus. Dr. J. G. Garson, in 1879, examined the thigh-bone and tibia of 70 skeletons of various ages and races in the museum of the Royal College of Surgeons of London, in only twenty per cent. of which the extremities were of equal length. The left leg was the longer in 38 cases, and the right in 25. The left femur in 46 cases, and the right in 20. It is worthy of note that in advanced life, and especially in persons who have suffered severely from chronic arthritic disease of the hip-joint, there is often, as all anatomists and surgeons know, great diminution in the length of the thigh-bone, from interstitial absorption of its head and neck, attended with great alteration in their form and direction. In this manner, shortening, often amounting to upwards of an inch, may readily be induced, as I know from the inspection of numerous specimens, and as I have long taught in my lectures.

Various contrivances for accurately determining any irregularities that may exist in the length of the lower extremities in health and after injuries have been devised by different surgeons, among others by Dr. T. G. Morton, and Dr. B. E. Gibbs, the former of whose paper on the subject, accompanied by a graphic illustration, may be found in the American Journal of the Medical Sciences for January, 1877.

3. COMPLICATED FRACTURES.

The only class of fractures, besides the simple, which deserves to be considered under a distinct head, is the complicated, as it is easy to comprise under this denomination every form of accident that can possibly arise either at the moment of the injury, or during the progress of the treatment. The most important topics requiring attention are wounds, hemorrhage, dislocation, comminution of bone, excessive laceration of the soft parts, erysipelas, pyemia, and, lastly, tetanus.

Complicated fractures may be oblique, transverse, or longitudinal, the frequency of their occurrence being in the order here enumerated. They are always caused by mechanical violence, as gunshot, falls from a great height, severe blows, or the passage of the wheel of a carriage, wagon, or railway car. Complicated fractures from the latter cause are very common, and are a frequent source of loss of limb and life.

The symptoms of this variety of fracture are, like those of simple fracture, sometimes extremely obscure, requiring great care and skill on the part of the surgeon to determine their character. In general, however, they are sufficiently well marked to enable him to distinguish them from such as attend other accidents, especially if the parts can be thoroughly examined before the supervention of much swelling. There are usually greater pain and shock than in an ordinary fracture, the resulting inflammation is more severe, and there is greater risk of violent secondary effects, as erysipelas, gangrene, copious suppuration, necrosis, caries, prostration, hectic irritation, and tetanus. In fact, complicated fractures are among the most serious occurrences that are met with in practice, being alike perplexing to the surgeon and dangerous to the patient; demanding the nicest judgment and skill for their successful management, and entailing, not unfrequently, the greatest possible suffering, horrible deformity, and loss of limb, if not also of life. It may be stated, as a general rule, that complicated fractures of the lower extremity are more dangerous and difficult of management, as well as more liable to be followed by distortion and permanent lameness, than those of the superior.

The process of repair in complicated fracture proceeds on the same principle as in the simple form of the lesion, only that it is usually more tedious, and that it is attended with a larger quantity of callus. When there is a wound in the soft parts, the union is generally effected through the medium of granulations, which, arising from the medulla of the Haversian canals and the central canal, are directly converted into osseous tissue, and thus form the connecting link between them.

The *treatment* of this form of fracture varies according to the circumstances of the case, or the nature and severity of the complication. When the case is associated with a wound in the soft parts, constituting what is called a *compound fracture*, as in fig. 432, and the limb is deemed capable of preservation, the first and most important consideration is the reduction of the fracture. This may generally be done by putting the limb in the most favorable position for relaxing its muscles, and by well-directed and gentle efforts at

extension and counterextension, along with proper manipulation, especially if the fracture is transverse, and the opening large; but if it is oblique, and there is a projection of one or both ends of the fragments, they occasionally fail, and compel us to resort to other measures. Under such circumstances, the soft parts which gird or bind the bone, and prevent it from yielding, should be carefully divided, when a renewed attempt at

Fig. 432.
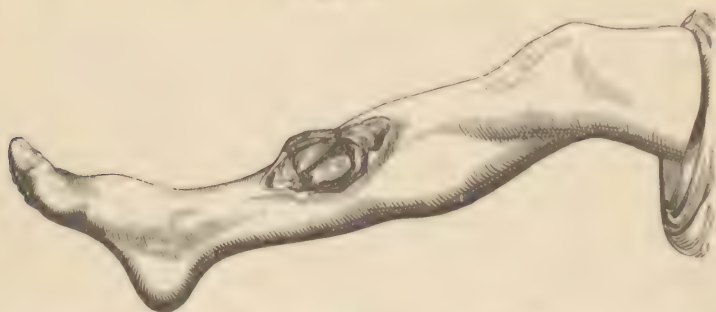
Fracture of the Leg complicated with Wound and Comminution of the Bone.

reduction will probably be successful. Should every reasonable effort of the kind, however, prove fruitless, then, instead of leaving the bone in its exposed situation, where it would be sure to die, the proper plan would be to cut away a portion of it, especially if it terminate in a very long and narrow point, care being taken to retain as much as possible of the periosteum.

Whatever may be the character of the wound, its edges should be carefully approximated by suture and plaster, aided by collodion to exclude the air; or, instead of this, the wound may be covered with a light compress wet with carbolized oil, and supported by a bandage. In this way, a compound fracture may occasionally be speedily converted into a simple one, union sometimes occurring in a few days. To facilitate cleanliness and the application of the dressings a bracketed splint must be used, one of the best of which is that of Dr. Packard, described in a future page.

Mr. Lister, in compound fractures, always injects the wound very thoroughly, as a preliminary measure, with a solution of carbolic acid, in the proportion of one part to twenty of water, the object being the prevention of suppuration by destroying the germs which, he alleges, constantly float about in the air, and which, if permitted to enter the wound, invariably interfere more or less with the reparative process. After the wound has been well cleaned and all fluid removed, the edges are adjusted in the usual manner, the surface is covered with a piece of protective antiseptic gauze, and the part is surrounded with lac plaster. The subsequent management is conducted upon general principles, the dressing being renewed as often as may be necessary, on account of the discharges, under a spray of a weak solution of carbolic acid continually playing upon the part, to prevent the ingress of air and of germs.

Whether carbolic acid, apart from the other means, recommended by Mr. Lister, is really of any benefit in the treatment of these injuries is still a mooted question. The rapidity with which wounds placed in the condition of subcutaneous wounds by the exclusion of the air heal, has long been familiar to surgeons. In India oil is extensively used for this purpose; and I have myself for many years employed this substance as a favorite dressing in all wounds made with the knife, as well as in fresh accidental ones. Sir Astley Cooper was in the habit of treating all compound fractures and dislocations with pledgets wet with the patient's blood, and confined by means of the bandage. Mr. Bennion, a Shropshire surgeon, enjoyed, as we are told by Mr. Adams, of London, great reputation for his successful treatment of compound fractures, accidents of frequent occurrence in his district, based upon similar principles. His method was, first, to effect thorough reduction of the ends of the fragments, even, if necessary, at the risk of great force; secondly, to clear away all effused blood; thirdly, to approximate carefully the edges of the wound; fourthly to cover the parts with a large pledget of lint, saturated with compound tincture of benzoin; fifthly, to bandage the entire limb, and support it with a well-fitting splint; sixthly, to put the patient at once under the influence of opium, maintained for a considerable length of time; and, lastly, to retain the dressings so long

as they did not cause any serious disturbance, evidently on the principle that meddlesome surgery is bad surgery.

A modification of the Lister treatment was introduced a few years ago into the New York Hospital by Professor Markoe, and has given most flattering results, only one death having occurred in nearly two hundred cases. The method consists in passing a large drainage-tube through a counter opening at the seat of the injury, in putting up the limb in plaster dressing provided with suitable fenestra, and in injecting a stream of carbolized water through the drainage-tube, at first every two hours and afterwards regularly three times a day until a cure is effected. No change of dressing is required; the thermometer rarely rises above 102° Fahr.; and the danger of erysipelas and pyemia is vastly lessened.

The opium treatment in these accidents cannot be too strongly commended. Much of the mischief caused by them is doubtless due to the neglect of its employment. Given in liberal doses, opium not only allays pain but prevents spasm and tranquillizes the system, all important elements of treatment in such cases. The wound should be most thoroughly closed by suture, proper provision being made for drainage, especially if the parts be much bruised or lacerated; and covered with lint wet with blood, benzoin, collodion, or Richardson's styptic colloid, supported by an oiled compress and a roller, extending from the distal portion of the limb.

The *hemorrhage* in complicated fracture may be open or concealed, according as there is a wound or no wound; arterial or venous; insignificant or copious. In the first case, the bleeding will manifest itself in the usual manner, and is to be arrested by ligature, acupressure, or compression; in the second, it will be indicated, if it is at all considerable, by unusual swelling, attended with a sense of fluctuation or unusual softness, and by more or less discoloration of the integument. If the principal artery of a limb has been severed, there will be an absence of pulsation in the parts below, with coldness of the surface. When no doubt remains concerning the diagnosis in such a case, the main trunk of the vessel is exposed some distance above the seat of fracture, and ligated; or, if this be deemed improper, an incision is made through the bloody tumor, and, its contents being turned out, the divided artery is sought and secured above and below the seat of injury. This, in fact, is usually the preferable procedure, especially as there must frequently be considerable uncertainty whether the effusion is arterial or venous; a circumstance which, perhaps, thus leads to the performance of a most serious operation in a case where one of a most simple character might suffice.

The formation of a distinct *aneurismal* tumor is very uncommon in injuries of this kind. The occurrence is denoted by pulsation, by thrill, and by a sawing, rasping, or purring noise, by circumscribed enlargement, and by the other usual concomitants. If the disease do not disappear spontaneously, as occasionally it does, an attempt must be made to effect a cure by compression, either digital or mechanical; or, if this fail, by ligation of the affected artery.

When a fracture is attended with a *dislocation*, the case necessarily assumes a very serious character, as it may give rise, especially if the joint involved is a large one, or the bone greatly shattered, to the question of primary amputation. In such an event the most experienced surgeon will often find it difficult to come to a prompt and correct decision. The principal circumstances which should induce him to make an attempt to save the limb are, the integrity of the patient's health at the time of the injury, together with a knowledge of his previous habits, and the simplicity of the dislocation, or the almost total absence of complication, as it respects the affected joint. If, on the other hand, the dislocation is compound, and the bone is badly broken, at the same time, perhaps, that it protrudes at the articulation; if all these injuries exist; or if, along with them, serious mischief has been inflicted upon the soft parts, as a violent contusion of the skin and muscles, or the laceration of important vessels or nerves, no doubt should be entertained respecting the propriety of the operation, and the sooner it is performed after the occurrence of reaction the better it will be for all parties concerned. I believe that a compound fracture, extending into a large joint, as the knee or ankle, and attended with extensive rupture of the ligaments, muscles, and other structures, should always, as a general rule, be treated in this way. It is true, a case apparently of the most desperate character occasionally recovers, but such a consideration should not have too much weight, or induce us to neglect a measure which is sanctioned not less by reason than by experience.

When the case is such as not to demand amputation, the dislocation should be reduced before an attempt is made to adjust the fracture. For this purpose the limb at the seat of the injury should be rendered as firm and immovable as possible by splints and bandages,

and the efforts persisted in until the object is attained. To wait until the broken bone has become sufficiently consolidated to enable it to bear the requisite manipulation would be sheer folly; one of two things would almost inevitably happen in such a case, either a reproduction of the fracture, or an utter failure to replace the luxated bone.

The most common causes of *comminuted* fracture are, gunshot violence, railway accidents, falls from a great height, and the passage of the wheel of a carriage. If the bone is splintered and any of the pieces are completely detached, or so loose as to render their reunion improbable, they must be carefully removed, the edges of the wound being afterwards gently approximated, and kept in position by sutures and adhesive strips, covered with collodion. The limb, surrounded by the bandage of Scultetus, and supported by appropriate apparatus, is placed in an easy position, and care is taken to moderate inflammation by the usual antiphlogistic means. If the wound suppurate, the best application will be an emollient poultice or the warm water-dressing, with as little disturbance as possible to the injured bone.

The so-called simple fracture, that is, a fracture without wound, is sometimes attended with a shattered and comminuted condition of the bones, imperilling limb and life, and imperatively demanding amputation. When there are only three or four fragments, and they admit of accurate adjustment, such an operation is of course not to be thought of, ordinary measures generally sufficing for a good cure.

A simple fracture becomes occasionally a complicated fracture from the manner in which the ends of the fragments pierce the muscles, thereby, although the fracture may be strictly subcutaneous, rendering it impossible to restore them to their proper relations. In such a case the only thing to be done, after failure of the ordinary means, is to cut through the skin and liberate the fragments with the bistoury, a procedure not likely to alter materially the risk of the case.

A fracture complicated with *impaction* of the ends of the fragments is occasionally a source of great annoyance to the surgeon. The most common sites of such a fracture are the head of the humerus, the lower extremity of the radius, and the neck of the femur. In most cases it will be good practice not to disturb the parts, but let them unite in their new position, as their separation is liable to be followed by want of union and other bad consequences.

When the fracture is complicated with violent *contusion* of the soft structures, the retentive apparatus should be applied rather slackly, and the parts kept constantly wet with cold water, or, what is better, a strong solution of acetate of lead and opium. If the inflammation run high, and the patient is strong and vigorous, bleeding, purgatives, and antimonial preparations may become necessary. The limb is carefully watched, in order that prompt advantage may be taken of any changes that may arise.

In gunshot fractures of the bones of the lower extremities attended with great displacement, Dr. Benjamin Howard, of New York, has on several occasions cut down upon the bone, and connected the ends of the fragments with silver wire. How far such a procedure may be judicious or proper, future experience alone can determine. When the tendency to displacement is very great, or cannot be controlled by the ordinary measures, I should think well of it; but few such cases will be likely to occur under the present improved system of treatment.

In consequence of injury sustained by the skin, either at the time of the accident, or from the pressure of the bandage, the cuticle is sometimes raised into little *vesicles*, filled with a thin, limpid, reddish, or yellow fluid. Such an occurrence always awakens anxiety both in the patient and practitioner, especially if he is young and inexperienced, as it is apt to be associated with the idea of gangrene. From this, however, it may always be easily distinguished by the absence of lividity, severe pain, and other symptoms of excessive action. The proper treatment consists in puncturing the vesicles with a fine needle, and dusting the surface with powdered zinc, unless the part is hot and inflamed, when water-dressing, simple or medicated, should be used.

If the principal artery, vein, or nerve of a limb has been destroyed, at the same time that there is extensive laceration of the soft parts around, the case will probably require amputation, especially if there has been severe shock or extensive hemorrhage, with previous derangement of the general health. Such a case is, at all events, a bad one, liable to be followed by loss of limb, if not also of life. If, on the other hand, the principal artery retains its integrity in the midst of the torn and broken structures, and the patient is young and vigorous, although he may have bled severely, we should by all means make an attempt to save the limb, having previously explained to the patient and his friends the risk which such an undertaking involves. Some of the most gratifying results that

reward the care and skill of the practitioner are cases of fracture complicated with extensive laceration of the soft structures and comminution of the bones. I have several times succeeded in effecting excellent cures when, the main artery being intact, the limb hung merely by a comparatively small quantity of skin and muscle, and when I was compelled to remove a number of pieces of bone, or even saw off the ends of the fragments.

A fracture complicated with *ankylosis* of a neighboring joint, or occurring in the bones of a stump, must be managed upon the same principles as an ordinary fracture, the apparatus being modified to meet the peculiar contingencies of the case. A fracture occurring in a paralyzed limb generally unites in the ordinary time, provided care be taken not to make undue compression during the after-treatment, lest it interfere with the nutrition of the bone and the formation of callus.

Accidents after Complicated Fractures.—The most common and important accidents after complicated fracture are spasm, erysipelas, œdema, abscess, gangrene, tetanus, pyemia, delirium, and congestion of the brain and lungs.

Spasm of the muscles is sufficiently common after all fractures of the limbs, but is especially liable to occur after fractures complicated with severe luxation of the soft structures and injury to the nerves from the contact of the sharp ends of the fragments. It is generally most severe and troublesome during the first two or three days, and always requires the liberal use of anodynes for its relief. The best local remedy is hot water medicated with acetate of lead and laudanum.

Erysipelas is very common after complicated fractures, and usually comes on within the first forty-eight hours after the receipt of the injury, manifesting itself in discoloration of the skin, more or less tumefaction and burning pain. The disease is most liable to appear in persons of intemperate habits, and in such as are dyspeptic, or enfeebled by previous suffering, and generally adds very much to the danger of the case, perhaps already sufficiently grave. Its extent and continuance will depend upon various circumstances, which will readily suggest themselves to the mind of the reader. The treatment is conducted upon general principles, the main reliance being upon the correction of the secretions, and the support of the system by fresh air, quinine, iron, milk punch, nutritious food, and anodynes, with the topical application of dilute tincture of iodine. Scarifications and incisions are not omitted in the event of great tension, or tension and suppuration.

The occurrence of *œdema* is sufficiently frequent in complicated fractures of old, dilapidated subjects, and is best remedied by the bandage, aided by spirituous lotions, tonics, and a nutritious diet. Punctures will seldom be necessary, and should always be employed with the greatest caution, as they are liable to be followed by bad sores and even gangrene.

Abscesses, diffuse, painful, and troublesome, may form at the seat of the fracture, or in its immediate vicinity. In either case, the matter should be speedily evacuated and thorough drainage established: otherwise it may not only cause extensive havoc among the soft parts, but caries and necrosis of the ends of the broken bone, with risk of pyemia and phlebitis.

Gangrene may be produced by injudicious bandaging obstructing the circulation, excessive inflammation, or injury of the main artery, vein, or nerve of the affected limb. The occurrence is most common in unhealthy subjects and in young persons after railway and other severe accidents, and often makes fatal progress before its presence is suspected by the patient or his attendant. Great pain in the part, of a smarting, pungent, or burning character, accompanied by discoloration and tumefaction in the distal portion of the limb, should always excite alarm and lead to a thorough examination. Tight bandaging, in particular, should be avoided in complicated fractures, especially in the early stages of the treatment.

Gangrene in complicated fractures is sometimes produced by excessive compression of the soft parts by extravasated blood, poured out in such quantity as to arrest the circulation in the principal vessels of the limb. Such an occurrence will be still more likely to take place when an important artery, vein, or nerve has been seriously wounded. The treatment must be by free incision and evacuation of the clotted blood, along with ligation of any wounded vessels above and below the seat of the injury. Amputation may be required if mortification has taken place.

Mere embolism may possibly give rise to gangrene below the seat of fracture, the blood coagulating in the principal vessels from the effects of inflammation independently of any pressure by the ends of the fragments. Such an event would be most liable to occur in a comminuted fracture, attended with great contusion and laceration of the soft structures, partially devitalizing the blood.

Secondary hemorrhage is an occasional occurrence in accidents of this kind, caused either by injury of an artery at the time of the fracture, or by the pressure of a fragment of displaced bone, producing ulceration in the coats of the vessel. In a case observed by Pelletan, the pressure exerted by a displaced piece of bone upon the anterior tibial artery caused profuse hemorrhage upwards of two months after the receipt of the injury, necessitating amputation. The management of such an occurrence must be conducted upon ordinary principles.

Necrosis of the ends of the fragments is not uncommon in compound fractures, especially if they have been stripped of periosteum, or long exposed to the air. The occurrence is denoted by the whitish and denuded appearance of the bone, the unhealthy condition of the granulations in the soft parts around, and the thin, watery nature of the discharges. In effecting retrenchment of the dead bone, whether with the hand or pliers, the same care must be taken to guard against hemorrhage, shock, and contusion of the osseous tissue. I have known a very slight loss of blood to be promptly followed by excessive exhaustion, placing the patient's life in jeopardy.

Severe *spasm* frequently attends this class of injuries, but as this subject has already been discussed in connection with simple fractures, nothing further need here be said respecting it.

Complicated fractures, especially if attended with loss of substance, are occasionally followed by the formation of a *false joint*, despite the best directed efforts of the surgeon. When the loss of bony matter is considerable hardly anything else is to be expected.

Chorea of a limb, whether existing previously to, or supervening after, the occurrence of the fracture, constitutes a very grave complication, seriously interfering with the success of the treatment. Chalybeate tonics, bromide of potassium, and anodynes, along with a properly regulated diet, afford the best chance of relief. In a case of fracture of the humerus, complicated with chorea, in charge of Dr. William Hunt, of this city, the patient died on the tenth day from the effects of the uncontrollable spasms of the limb.

Pyemia, as an effect of complicated fractures, is uncommon, at least in private practice, except when the accident has been caused by railway injury, the bursting of a gun, the passage of the wheel of a wagon, or some similar violence. It is distinguished by its usual insidious character, and generally sets in from the fifth to the tenth day, its approaches being announced by violent rigors, alternating with flushes of heat, great depression of the system, delirium, and excessive restlessness. The structures which are most apt to suffer are the lungs, liver, spleen, joints, and connective tissue. The treatment is supportant and alterant; by quinine, iron, brandy, and nourishing broths, for the former; by the sulphites of sodium and potassium, in moderately large and properly sustained doses, for the latter. In general, such cases fare badly, death occurring within a week from the commencement of the attack, despite our best directed efforts.

Tetanus, in complicated fractures, is most liable to supervene in nervous, irritable subjects, during hot weather, although it may take place at any season of the year, as well as in every description of individuals. It is an extremely formidable symptom, which should be promptly met by the removal of the affected parts, and by large quantities of anodyne and antispasmodic remedies. If occasionally a case is cured without amputation, it forms the exception, not the rule. In such an event, there is no time for delay; whatever is done must be done quickly and effectively, at the very inception of the disease, before there is any decided evidence of stiffness in the muscles of the jaw.

Traumatic *delirium* is sufficiently frequent after these accidents, especially in old intemperate persons, and should be treated upon the principles laid down in a previous chapter, the most important remedies being bromide of potassium, chloral, aconite, and opium.

Congestion of the *lungs* and other internal organs, as a consequence of these injuries, is most liable to occur in elderly persons, as a result of a determination of blood either from actual irritation or a sluggish condition of the vessels during protracted confinement. As such attacks are very liable to prove disastrous, everything should be done to prevent them, by getting the patient as speedily as possible out upon crutches into the open air.

Fatty embolism of the lungs and other viscera, caused by oil globules introduced into their substance by the veins at the seat of the fracture taking up some of the crushed marrow, and carrying it to these organs, where it causes fatal obstruction, is an occasional occurrence after such a lesion. The possibility of such an occurrence was first enunciated in 1862 by Zenker and Wagner, but it remained for Busch and Czerny to establish the fact by actual dissection. In the case reported by Czerny, the patient, a stout, healthy man, thirty-two years old, had a simple fracture of the thigh-bone, which was followed soon after the accident by symptoms of pulmonary obstruction, terminating in death in less than forty hours.

The post-mortem examination revealed the existence of great numbers of oil globules in the capillaries and smaller arteries of the lungs, brain, liver, and kidneys. Observations made by Bergmann, Déjérine, Hamilton, Busch, and others show that, while this form of embolism is most common after fractures, it may also take place in caries, in osteomyelitis, in bony tumors, in fatty degeneration of the liver and arteries, and in certain abscesses developed in regions abounding in adipose tissue.

Fractures of the *joints* are frequently complicated with sprains, laceration of the ligaments, detachment of portions of bone and cartilage, and extravasation of blood. The inflammation consequent upon such injuries often runs very high, large quantities of synovial fluid are liable to be effused, and the swelling in the surrounding structures is frequently very extensive. A severe sprain always adds greatly to the suffering, increasing the pain, and delaying recovery. In many cases the nutrition of the limb is seriously impaired, the muscles become atrophied, the skin is cold and discolored, motion is impeded, and the general health is more or less deranged. Extensive laceration of the ligaments is frequently followed by permanent ankylosis, or by such an amount of disorganization of the proper structures of the joints as to lead to the necessity of resection or amputation. When the articular extremity of a bone is severely shattered, a small fragment is sometimes completely detached, and, falling into the joint, sets up violent, if not destructive, inflammation. A piece of cartilage, however minute, may occasion similar effects. Abscesses, either circumscribed or diffused, are liable to form as a consequence of such injuries, sometimes at a period quite remote from their occurrence. More or less extensive extravasation of blood generally takes place in fractures of the joints, both into their interior and into the surrounding connective tissue, not only obscuring the diagnosis, but seriously impeding the cure. Permanent ankylosis occasionally follows upon a complicated fracture, even when situated at a considerable distance from a joint, simply from an extension of the resulting inflammation.

The *nerves*, like the bloodvessels, often suffer severely in fractures, sometimes at the moment of the injury, from contusion, laceration, or compression by sharp or displaced pieces of bone, or more or less remotely from the manner in which they are constricted by the plasma that is effused around their trunks at the seat of the original mischief. Exuberant callus may occasion similar effects, as I have witnessed in several cases. Whatever the cause may be, the suffering generally manifests itself in pain, more or less severe, and often of a neuralgic character, a sense of numbness, coldness or tingling, gradual wasting of the muscles, great susceptibility to atmospheric impressions, dryness and roughness of the skin, superficial ulcerations, the formation of little vesicles, desquamation of the cuticle, partial paralysis, and a tendency to ankylosis of the joints near the seat of injury. Some of these affections are remediable, yielding gradually to sorbefacient lotions, the hot and cold douches, and veratria ointment; others, on the contrary, obstinately persist despite the best directed efforts of the surgeon. Now and then relief, prompt and permanent, follows excision of a portion of the affected nerve.

The *muscles* and tendons passing along the seat of fracture often sustain serious injury, in the first instance from the displaced extremities of the fragments, fretting and irritating their fibres; and, at a later period, from their involvement in the callus, which, when this substance is unusually abundant, surrounds and compresses them in such a manner as to interfere permanently with the exercise of their functions.

As a remote effect of a fracture, even of the most simple kind, there is occasionally a development of sarcoma at the seat of injury, coming on within a variable period after its occurrence, and characterized by rapid formation and great bulk. In a case recently under my observation, an immense tumor of this kind existed in the forearm, in a boy, eight years old, who, twelve months previously, met with a fracture of the ulna. Latterly the lymphatic glands of the corresponding axilla had become involved, and the general health showed marked evidence of impairment. A section of the tumor exhibited, under the miscroscope, a typical round-celled structure.

Amputation.—The circumstances which are likely to call for primary amputation have already been casually alluded to, and it may now be added that the operation should always be performed, as a general rule, whenever, along with a shattered or comminuted condition of the fractured bone, there is extensive laceration of the soft parts, with almost total disorganization of their substance. It is true, as was before intimated, that apparently desperate cases are sometimes cured, and that limbs, so mashed and wounded as to render amputation the only probable chance of success, are now and then saved. But it is equally true that such instances are extremely rare, and if we take into account the protracted sufferings of the patient, and the likelihood that he will ultimately perish, the

reasons for performing immediate amputation are, to use the language of Percivall Pott, "vindicable upon every principle of humanity or chirurgic knowledge."

It is not uncommon to meet with cases in which the fracture is *multiple*, or in which the bone is broken at several points, but the upper fracture is perfectly simple, and perhaps situated in a portion of the limb which it is desirable to preserve. Hence it becomes an important question how the surgeon should act in such an event. To my mind, the subject is a very plain one. If it is really important to save the broken bone beyond the part that must necessarily come off, in order to make a longer and better stump, there can certainly be no objection to such a course, provided, however, that the proximal fracture is perfectly simple in itself, and that there is no serious lesion of the soft structures, endangering limb and life by gangrene or other bad consequences. I have more than once adopted this plan, without ever having had any cause to regret it. No sensible surgeon would, of course, allow a bone to remain, if, in addition to extensive comminution, there is serious injury of the muscles, integument, or other important textures ; to do so would only be to trifle with the safety of the case. Severe fractures, the result of gunshot injury, nearly always demand primary amputation, especially when they occur on the battle-field.

Secondary amputation may be required when, after an attempt to save a limb, and the employment of suitable antiphlogistic remedies, the parts become gangrenous; or when the consolidation of the fracture is prevented by profuse suppuration, and the patient is gradually worn out by diarrhœa and colliquative sweats. In the first case, the operation is performed as soon as the mortification is arrested, and there is a distinct line of demarcation between the dead and living parts ; in the second, as soon as it is perceived that the suppuration cannot be arrested, and that the patient has still sufficient strength to bear the pain and shock which must necessarily attend its performance.

4. INCOMPLETE FRACTURES OR BENDING OF THE BONES.

The bones are liable not only to break, but also to bend, as seen in figs. 433 and 434. Such an accident can only happen in young subjects, principally infants and children, in whom the osseous tissue, containing a preponderance of animal matter, is comparatively soft, flexible, and elastic. Bending of the bones of the skull, especially the frontal and parietal, is occasionally witnessed at an early age, as an effect of external violence, as that, for instance, produced when a child falls, head foremost, down a flight of stairs, or out of a second-story window upon the pavement below. Under such circumstances, the cranial bones, at the part struck, are depressed beyond their natural level, and yet there is not, so far as can be ascertained, any fracture, strictly so called ; they are merely bent or indented, and, if no untoward occurrence take place, they will, generally, in the course of a few days, resume their proper position

Fig. 433.

Fig. 434.

Incomplete Fracture of the Bones of the Forearm.

by their own resiliency, aided, doubtless, by the locomotive action of the brain, propelling them outwards away from its surface. In an adult, an accident, capable of producing such a result, would almost inevitably lead to fracture of the skull, probably of a very grave character, for the reason that the cranial bones, after a certain time, are always loaded with a quantity of earthy matter, in the form of carbonate and phosphate of lime, the presence of which renders them more or less brittle, and thus predisposes them to fracture. This tendency to fracture increases in proportion as we advance in years, and is, consequently, most distinctly marked in old age and decrepitude, in which the osseous tissue, almost destitute of animal substance, generally yields under the slightest force, the accident frequently eventuating in incurable injury.

Bending of the bones was incidentally observed by a considerable number of practitioners in the last century, and, indeed, even prior to that period ; but the first systematic account of it was published in 1810, by Professor Jurine, of Geneva. In 1821, it was described

by Dr. John Rhea Barton, and since then it has been carefully investigated by Professor Hamilton and other surgical pathologists.

I have myself met with this accident in ten cases, in children whose ages varied from three to eleven years, three being girls, and the other seven boys. Although it is most common in the ulna, radius, and clavicle, it also sometimes occurs in other pieces of the skeleton, as the humerus, femur, tibia, fibula, and ribs. External violence alone is capable of producing this lesion. I am not acquainted with any cases in which it was occasioned by muscular action. In fact, considering that bending of the bones is exclusively confined to children, it is hardly possible that the accident could arise from such a cause; certainly not, unless there existed extraordinary muscular development with remarkable flexibility of the osseous tissue, a condition hardly compatible with a healthy state of the system. In the bones of the forearm, which suffer more frequently than any other, the injury usually originates from force applied indirectly, as, for example, when a child, in the act of falling, instinctively throws out the arm to protect the body, and so receives the shock upon the hand, the concussion concentrating and exploding upon the radius, or the radius and ulna. In one of my cases, the bend was produced by the body of the child being suddenly propelled against the forearm at a moment when the elbow was planted upon the floor, and the wrist was lying upon a stool. Flexion of the clavicle is the result either of direct violence, or of force applied to the top of the shoulder, especially if the body is at the same time propelled in the opposite direction, as in the case of a fall.

The seat of this lesion is variable; in the long bones, as those, for instance, of the forearm, it usually occurs a short distance below their middle, but it may also take place higher up, or farther down. The radius and ulna may both suffer synchronously, but very frequently one alone is affected; or, if both are implicated, they do not suffer in an equal degree.

Judging from the cases of this accident that have fallen under my observation, I am induced to believe that it generally takes place without any particular predisposition, either local or constitutional. In every instance of the kind, the subject of the injury was in good health at the time of its occurrence. An exception, however, must be made in regard to the bones of rachitic children, in which incomplete fractures are always preceded by softening.

What is the precise nature of this lesion? Is it really, as the name implies, a mere bending of the bones, or is it a flexion combined with partial fracture? These questions are easily answered. In very young subjects, as in children not more than a few years of age, and in the milder forms of the lesion, the osseous fibres are merely extended or stretched, so as to permit themselves to be drawn out of their natural course; in cases of an opposite character, on the other hand, there is no doubt, that while some of the fibres are bent, others are both bent and broken. These conclusions are beautifully borne out by the experiments of Dr. Hamilton upon the bones of young chickens, which, from the fourth to the sixth week, and, consequently, before the completion of the ossific process, could readily be bent without fracture to an angle varying from twenty-five to thirty-five degrees; whereas the bones of older chickens, thus treated, always partially broke, their fibres being incapable of withstanding the force used in flexing them.

These partial fractures, sometimes called interperiosteal, from the fact that the periosteum remains intact, bear a close resemblance, in the mode of their production, and the nature of the resulting injury, to the appearances presented by a green hickory stick, forcibly bent over the knee, but not to such an extent as to occasion any external sign of fracture, although it will be found, upon making a section of the wood, that many of its fibres have actually been broken, while others, and, perhaps, the greater number, have merely been bent. These appearances are well shown in fig. 435, from Fergusson.

Fig. 435.

The symptoms attendant upon this accident are pain and deformity at the seat of the injury, loss of power in the limb, and absence of crepitation. The pain varies in degree, being sometimes slight, at other times severe; swelling soon supervenes, and the part feels numb and heavy. A marked curvature, generally very gentle, but occasionally quite abrupt, always exists at the affected part, and can seldom be completely effaced without the application of very considerable force; indeed, often not without breaking the bone entirely across, especially if it was partially fractured previously. In the latter case, there is usually at the convexity of the curvature a slight depression, capable of receiving the point of the
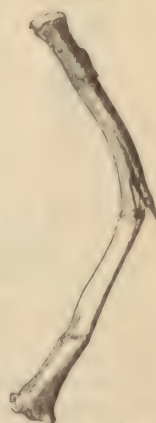
Case mentioned by Fergusson.

finger, its boundaries being formed by rough, sharp, bony fibres. Further than this there is no displacement, and under no circumstances is there any crepitation. The use of the limb is always greatly impaired, but not completely destroyed, as it commonly is in ordinary fracture. Finally, I may mention, as another highly important and diagnostic sign, the great difficulty which is so frequently experienced in restoring the parts to their proper position.

The *treatment* must be conducted upon the same general principles as in ordinary fractures. When the bones are merely bent, slight pressure and extension usually suffice to accomplish restoration, the affected parts being compelled, as it were, to retrace their former steps. If flexion be conjoined with partial solution of continuity, the reduction will necessarily be more difficult, and may, in fact, altogether fail, owing to the manner in which the osseous fibres are interlocked with each other, and the inability which is experienced in disengaging them, so as to induce them to slip back into their proper position. However this may be, the attempts to remove the curvature by extension and pressure should neither be too violent nor too long continued, lest they prove injurious. The object should be to restore as much as possible by gentle means ; what cannot be effected in this manner may well be left to the operation of time, the absorption of the broken and resisting osseous fibres, and the action of the muscles, which seldom fails to reinstate the parts, although from six to eight weeks may elapse before the final completion of the cure. I have generally found the use of leather splints, well padded, and accurately shaped to the limb, of great service in bringing the bones into their proper relations. Pressure with the elastic bandage, as suggested by Dr. H. A. Martin, of Boston, will also be found to be very useful. When the accident is followed by grave inflammation, the usual antiphlogistic remedies, especially leeching and cooling lotions, will be required.

There is a variety of partial fracture, known by the term *fissure*, which is peculiar to the bones of elderly subjects, no well-marked instance of it having ever been met with in infants and children. Such an occurrence, which is generally much more interesting in a pathological than in a practical point of view, is by no means uncommon in the skull, especially along its base, where it is always associated with severe, and frequently fatal, injury of the brain and its envelops. The fissures in many of these cases are most extensive, involving the sphenoid, occipital, temporal, frontal, and, perhaps, even the ethmoid and parietal bones. In the other pieces of the skeleton the occurrence is more rare ; but examples are occasionally seen both in the long, short, and flat bones, as the result of external violence, generally directly applied. The accident is, now and then, produced by gunshot injury. The lesion, however induced, consists essentially in a forcible separation of the osseous fibres, and exhibits itself in a great variety of forms, the crack sometimes extending through the entire thickness of a bone, at other times merely through its outer table, and at other times, again, involving both the compact and areolar tissues,

Fig. 436.

Hyperostosis after Greenstick Fracture.

but not passing completely through them. The length of the fissure varies from a few lines to a number of inches, perhaps as many as six or eight, although this is exceedingly uncommon. The width of the crevice is generally very slight, perhaps barely sufficient to admit the blade of a penknife. In rare cases, as when it involves the extremity of a bone, it may gape somewhat, so as to give the part the appearance as if it consisted of two fragments, firmly adherent at one end. Finally, the fissure may be straight, curved, or angular.

Of the rarity of this lesion, as an uncomplicated occurrence, an idea may be formed when it is stated that there are probably not more than three or four well-marked specimens of it in all the osteological cabinets of this city. As a conjoint affection, it is occasionally met with in compound fractures, especially when caused by railway accidents. There are no signs by which the nature of the injury can be distinguished during life ; a circumstance which is the less to be regretted, because the treatment does not differ from that of ordinary wounds, fractures, and contusions, with which it is so generally associated.

Bryant has described a rare case of deformity, fig. 436, consequent upon a green-stick fracture of the leg, in which the bones were allowed to remain in the position into which they were thrown by the accident. The tibia and fibula measured six inches across the centre, owing to the deposit of a large quantity of osseous matter in the concavity of the arch.

5. EPIPHYSEAL FRACTURES.

The extremities of the bones of young subjects are united to their shafts or bodies by means of cartilaginous matter, which, in some of the pieces, and in some individuals, does not assume the osseous form until after the twenty-first year, and occasionally, indeed, not until even a later period. Up to this time, consequently, these junctions are liable to be severed, so as to allow the contiguous extremities to separate from each other, and it is this occurrence which constitutes what is technically called diastasis, as seen in fig. 437; an affection first accurately described nearly at the same time by Roux and Guéritin.

Fig. 437.

Diastasis of the Femur: reunited.

It is probable that this accident may occur in all parts of the skeleton united in this manner, although there are, doubtless, some in which it is more common than in others. Its occasional existence has been recognized, by dissection, in the humerus, radius, femur, and tibia, and there are few systematic treatises that do not allude to it as being now and then met with in some of the other bones. The most common cause of diastasis is a wrench of the part, violent traction, or a severe fall. I am not aware that it has ever been produced by muscular action; and, on the other hand, it is rarely the result of direct violence, as, for instance, the kick of a horse, or the passage of the wheel of a carriage, such an accident more generally eventuating in fracture of the bones than in a separation of their epiphyses. The lesion may happen at any period of life, prior to the completion of ossification, but is most common from the fifth to the fifteenth year. Its occurrence in middle-aged and elderly subjects is, for the reasons already mentioned, impossible. Girls are more prone to it than boys, owing, probably, to the fact that they are more frequently exposed to its exciting causes. The affection, like fracture, may be simple, compound, or complicated. Cases are noticed in which the diastasis is blended with fracture of the shaft of the bone, and it is by no means uncommon to find that small processes of bone are dragged away with the epiphyses.

The symptoms of this lesion do not differ essentially from those of fracture, properly so called. Its existence may generally be suspected when an accident affecting a bone occurs in a young subject, in the neighborhood of a joint; when the ends of the fragments are transverse, or nearly so; when the articular piece retains its position, while the other moves about; and, lastly, when the crepitation produced by rubbing the ends of the fragments against each other is of an unusually dull, rough, grating character. Moreover, it will commonly be found that the parts, when once reduced, are less liable to be dragged asunder by the action of the muscles than in an ordinary fracture.

The prognosis is generally favorable, union commonly taking place very promptly, especially in very young subjects. The accident, if neglected, or unskilfully treated, is liable to be followed by severe inflammation, abscesses, erysipelas, and more or less deformity. The treatment is the same as in ordinary fractures.

6. UNUNITED FRACTURES.

Fractures occasionally refuse to unite, either in consequence of causes inherent in the part or system, or on account of mismanagement growing out of the surgeon's want of attention and skill, or else out of the patient's own misconduct. It is practically important that a distinction should be drawn between a fracture that unites tardily and one that does not unite at all, or only through the medium of fibrous, ligamentous, or fibro-cartilaginous tissue. Slow consolidation is by no means uncommon; the parts may be loth to take on the requisite degree of ossific action, and the result may be that a fracture that is ordinarily repaired in four or five weeks, may, perhaps, be still imperfectly united at the end of twice that period. The process of restoration is only held in abeyance, neither advancing nor receding; by and by it begins again, and then often proceeds with its wonted rapidity. Such cases are frequently very trying to the surgeon's patience, although they generally turn out well in the end, provided sufficient care has been taken to preserve the parts in their proper relations. In the ununited fracture, on the other hand, the process of consolidation is either completely thwarted, or, after having made some progress, is at length permanently arrested. Under these circumstances, the ends of the fragments are gradu-

ally rounded off by absorption, and remain either entirely loose and unconnected, or they become adherent through the medium of fibrous, ligamentous, or fibro-cartilaginous

Fig. 438.

Ununited Fracture of the Bones of the Leg.

matter. Sometimes, although rarely, an adventitious joint is formed, as in fig. 438, provided with a more or less distinct synovial membrane, thus permitting the ends of the bone to move upon each other with great facility.

The bones most liable to non-union after fracture are those of the arm and thigh. Of 150 cases collated by Dr. George W. Norris, 48 related to the humerus, 48 to the femur, 19 to the forearm, 33 to the leg, and 2 to the lower jaw. Bad injuries of this kind of the clavicle, rendered so by severe contusion and great displacement of the ends of the fragments, are often followed by imperfect consolidation. The occurrence of non-union, however, of fractures generally is probably much less frequent than is usually supposed. Of nearly 4000 cases treated in the Middlesex Hospital, London, there were, as stated by Lonsdale, only five or six of non-union. Of 946 cases of recent fractures admitted into the Pennsylvania Hospital, from 1830 to 40, not an instance of the kind occurred; and of 367 cases, treated in the Massachusetts General Hospital, there was, according to Dr. Moreland, only one in which a false joint had formed. Within the last few years not less than five cases of this kind have come under my observation, three of them in the Jefferson College Hospital.

Want of reunion in a fracture may depend upon a great variety of *causes*, some of them inherent in the parts themselves, others connected with the system. Thus, it may be occasioned by the interposition of a clot of blood or of a piece of muscle, tendon, or bone. An instance is recorded where the consolidation of a fracture was prevented by the presence of a musket ball; and Dupuytren observed a fracture of the humerus, in a man, twenty-three years of age, in which a similar effect was produced by the lodgment of a large number of hydatids. Fragility, softening, and other affections of the bones, are usually enumerated as circumstances interfering with the reparative process, but it is not improbable that their influence has been greatly exaggerated : at all events, it is certain that in many cases of this kind the fracture unites as readily as when the bones are perfectly healthy. Too much motion, the long-continued use of cold water, especially in persons of a nervous, irritable temperament, and tight bandaging, may also bring about this result. Many years ago, I saw a case in which, from the latter cause, the consolidation of a fracture of the thigh-bone was delayed for nearly twelve months. The limb had become excessively atrophied from the protracted and injudicious employment of the roller, and it was not until after the bandage had been entirely laid aside, and the man permitted to exercise upon crutches in the open air, that nature fairly began the process of repair.

Old age is no barrier to reunion, if the patient is in good health at the time of the accident, and the fracture, unattended by complications, is properly treated. I have met with several cases of fracture of the humerus, in persons after the eightieth year, followed by complete consolidation in the usual time ; and Dr. W. W. Dale has reported one in a lady of one hundred, in which the union was equally prompt and satisfactory. A fracture of the upper third of the thigh, in a woman, ninety-three years old, treated by Dr. J. K. Holloway, of Ohio, was completely consolidated in seven weeks.

The most common of all the local causes of tardy reunion, in injuries of this kind, are motion and imperfect apposition of the ends of the fragments. Either of these circumstances will inevitably interfere with, if not effectually prevent, the consolidating process, however favorable to a cure the condition of the system itself may be. Hence, as stated elsewhere, the absolute necessity, in every fracture, of carefully guarding against those occurrences until the process of repair is so far advanced as to enable the fragments, so to speak, to take care of themselves.

Fractures situated at or near the entrance of the nutrient arteries unite less rapidly than such as are situated further off, as they interfere more or less with the circulation

and nourishment of the osseous tissue. It is easy to suppose that the laceration of these vessels, as occasionally happens both in simple and compound fractures, might be a cause of non-consolidation, especially when conjoined with other unpropitious circumstances. Statistics show that, when the supply of blood is cut off, to any considerable extent, so as to impose upon the periosteum the exclusive duty of nourishing the fragments, either one or both pieces will become atrophied, their walls being visibly thinned and their areolar structure rarefied.

Inadequate supply of nervous fluid may be a cause of non-union. A case reported by Mr. Travers beautifully illustrates this point. A patient had a fracture in the arm and another in the leg, complicated with an injury of the spine which palsied the lower half of the body. The broken humerus readily united, but the tibia and fibula refused to heal.

Want of union is sometimes dependent upon the absorption of the ends of the fragments, or even of the greater portion of the fragments themselves, as in a very singular case which came under my observation in a man, fifty-three years old. At the age of eighteen, he received two simple fractures of the right humerus, at an interval of three months, one being situated about the middle of the bone, the other an inch and a half higher up. The first was repaired in the usual time, but the second refused to unite, the ends of the fragments becoming rounded off, as in the formation of an artificial joint; the process gradually proceeding, the whole bone was finally absorbed, nothing remaining except the condyles and a little of the head. The period occupied in the absorption was about six years, the general health being all the while unimpaired. The muscles of the arm are well developed, and are capable, when thrown into powerful action, of diminishing the interval between the shoulder and elbow to an extent of several inches. Although the man is unable to perform any of the usual movements of the limb, he can readily raise a weight of upwards of one hundred pounds, and can apply his hand to various purposes. The accompanying cut, fig. 439, represents the appearance of the arm during the contraction of its muscles.

Fig. 439.
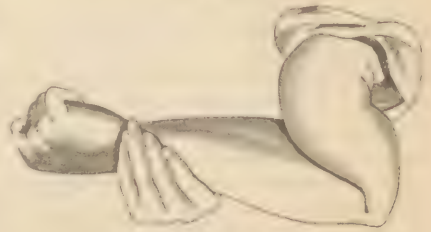
Absorption of the Humerus.

The principal constitutional causes which interfere with the reparative process are, debility, whether from loss of blood, want of nutritive action, or exhausting disease, as long-continued fever, a gouty, rheumatic, scorbutic, rachitic, or syphilitic state of the system, and loss of nervous influence, however induced. Pregnancy has sometimes been accused of preventing union, on the ground that the nourishment required by the fœtus establishes too great a drain upon the blood; but in the few cases of this kind that have fallen under my observation, I have not witnessed any such effect, and I am strongly inclined to believe that this influence has been greatly exaggerated, if, indeed, it is not wholly chimerical. The same remarks are applicable to suckling. Another cause, probably much more efficient, as well as much more common, is the protracted and inordinate use of ardent spirits, exhausting the nutritive energies of the system, and rendering the blood and its vessels unfit for the performance of the important duties assigned to them in the reparative process.

Treatment.—Whatever the cause of the non-union may be, every effort should be made to discover it, with a view to its early and efficient rectification. Nutritious food and drink, as porter, ale, wine, or brandy, aided, if necessary, by tonics, more especially iron and quinine, will be required if the patient be very weak or anemic. A gouty or rheumatic state of the constitution is best remedied by purgatives, alkalies, and colchicum. Syphilitic symptoms must be met with the iodides, in union with mercury, the latter of which should sometimes be carried to the extent of slight ptyalism. Debility from drunkenness must be counteracted by the judicious employment of the patient's accustomed stimulants.

Sometimes a change of air is very serviceable, especially such as attends upon a sea-voyage. An army surgeon, stationed in the West Indies, had under his care six cases of fracture which remained ununited for a long time, but were all promptly cured on being sent to Europe.

The local treatment must be regulated by circumstances. The precise cause of the tardy or imperfect union must, if possible, be clearly ascertained, and promptly remedied by appropriate measures. If any motion exists perfect quietude must be insured; any defect of contact must be redressed by a more accurate adjustment of the ends of the frag-

ments; cold applications, if injurious, must be discontinued; and any extraneous intervening substance must be removed, either through the agency of the absorbent vessels, by pressure and other means, or, as in the case of a piece of dead bone, with the knife and forceps. The cause of the defective union having been thus remedied, the case will be likely, of its own accord, to proceed to a favorable termination, the ordinary principles of treatment being, of course, observed.

A large number of local remedies have been employed for the cure of united fractures. Among these the most important are friction, compression, vesication, acupuncturation, cauterization, subcutaneous division or perforation, the use of setons and ivory pegs, and excision of the ends of the fragments.

1. Cutaneous friction, either dry or moist, by means of the bare hand, or with a piece of rough cloth is sometimes serviceable, especially in the more simple cases; if moist, various liniments, lotions, or unguents may be employed, often with decided benefit, inasmuch as they tend to excite capillary action in and around the ends of the fragments, thus promoting the formation of callus.

2. Compression is occasionally worthy of trial. It may be made with splints of leather, felt, or binder's board, and the bandage; or by an apparatus expressly constructed for the purpose, and so arranged as to concentrate the pressure at the seat of the fracture. It must be steady and persistent as well as uniform and gentle.

3. Blisters and iodine now and then act beneficially. Their application is particularly indicated when the want of union is dependent upon undue vascular excitement, and is, of course, entirely restricted to cases of recent standing.

4. Friction of the ends of the fragments against each other was recommended by Celsus, and has often been successfully practised by modern surgeons. It should be performed very gently, and be repeated every four, six, or eight days, according to its effects.

5. Percussion of the ends of the fragments, originally recommended by H. O. Thomas, of Liverpool, has been successfully employed in some cases of ununited fractures, more especially in cases of recent standing. The skin at the seat of the fracture being protected with felt or sole leather, and the patient placed under the influence of an anæsthetic, the ends of the broken bone are smartly struck five or six minutes with an iron hammer. The operation is followed by a good deal of swelling, which, however, promptly disappears under local treatment.

6. Acupuncturation with a long, slender needle may be tried; or a small incision may be made over the seat of the injury, and a heated wire thrust between the ends of the fragments. The galvanic cautery might, perhaps, occasionally be employed with advantage, especially when a more powerful excitant is needed.

7. Cauterization of the integument over the seat of the fracture with some caustic alkali, was recommended and successfully employed, in 1805, by Dr. Hartshorne, of this city. Sometimes the ends of the bones may advantageously be exposed, and rubbed over with nitrate of silver, although such a proceeding is not always devoid of danger.

8. Subcutaneous division of the ligamentous bands between the two ends of the fragments has been successfully practised. The operation is performed with an ordinary tenotome, used in such a manner as to cut the parts as thoroughly as possible, especially over the extremities of the broken pieces.

Fig. 440.

In very recent cases, such a procedure is occasionally followed by a good cure. In using a tenotome for such a purpose care must be taken not to wound any important vessels or nerves.

9. The injection of five to ten drops of glazial acetic acid between the ends of the fragments, in cases of recent standing, has been successfully employed by Fitzgerald. The fluid acts, as is supposed, by softening the interposed fibrous tissue, and thus placing it more readily under the influence of the absorbent vessels. The smarting pain which follows the operation always speedily subsides of its own accord.

10. The introduction of ivory pegs was originally proposed by Dieffenbach. They are from an inch and a half to two inches in length, conical in shape, and inserted into the ends of the fragments, previously pierced with a gimlet, such as that sketched in fig 440. They must be forcibly driven into the openings, and retained until the consolidating process is well advanced. Excellent and rapid cures have repeatedly followed this plan in my hands.

11. The seton, introduced into practice in 1802, by Dr. Physick, is ordinarily, in
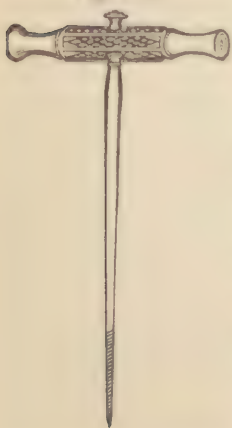
obstinate cases, a very reliable, but not always a safe method, as it is liable to give rise to erysipelas and other bad consequences. It should be passed by means of a long, thin, flat needle, sharp and lancet-shaped at the point, between the ends of the fragments; or, if this be impracticable, as close to the site of the fracture as possible, for experience has shown that the operation, thus performed, is nearly as successful as the usual procedure. The foreign body, a piece of elastic tape, silk ribbon, or French braid, is generally retained until it has excited slight suppurative action. The patient is carefully watched, the seton being at once withdrawn, if the pain and swelling become at all severe. Immediately after the introduction, the fragments are properly adjusted, and steps taken, if necessary, to maintain extension and counterextension. In the first case in which this treatment was employed, the seton was retained many weeks, and the patient recovered the perfect use of his limb. The practice of withdrawing the seton at the end of a few days, as is occasionally advised, is objectionable, for the reason that it will hardly have sufficient time to excite the requisite degree of inflammatory action.

12. Perforation of the ends of the bone by means of a special instrument, fig. 441, an operation proposed, in 1853, by Professor Brainard, is sometimes serviceable. It consists in piercing subcutaneously the extremity of each fragment at several points, and cutting

Fig. 441.

Brainard's Perforator.

up the intervening tissue, with a view of exciting ossific action. The instrument should have an immovable handle. A preliminary puncture is made with the bistoury, and any hemorrhage that may arise is controlled by compression. The operation is repeated every eight, ten, or twelve days until consolidation has occurred, the limb being in the mean

Fig. 442.　　　　　Fig. 443.

Gaillard's Fracture-pin.

time kept quietly at rest in splints, and the treatment being in other respects conducted upon general principles. From what I have seen of the effects of this treatment, I am satisfied that it is adapted chiefly to cases of delayed union, and that it is altogether inadequate in those of long standing.

13. Connecting the ends of the fragments together subcutaneously by means of an iron screw, as originally practised by the late Professor Pancoast, in 1857, often succeeds where the more ordinary plans prove abortive. Indeed, I know of no method of treatment that is so effective and at the same time so perfectly free from danger as this in old ununited fractures and in recent false joints. It is particularly suited to ununited fractures of the femur and humerus, but is not so well adapted to those of the leg and forearm, in which it occasionally fails. The instrument, fig. 442, with which the operation is performed, is shaped somewhat like a gimlet, and is provided with a movable handle. A puncture being made down to the seat of the fracture with a long, narrow bistoury, the screw is carried through the end of one fragment into that of the other, and retained until there is complete consolidation, from six to eight weeks being usually required to accomplish the object. When the treatment is over, the instrument may be removed; or, if it do not cause any inconvenience, it may be permanently left, the more especially when it is completely buried beneath the skin. Its presence is rarely, in any case, productive of

Iron Screw for connecting the Ends of Ununited Fractures.

serious inconvenience. Now and then slight erysipelas arises after the operation, but this generally soon disappears of its own accord. In the seven or eight cases in which I have employed this treatment the success in all was complete. In three of these cases the screw was retained upwards of four months. Such a procedure will not be likely to succeed well when an artificial joint exists.

Dr. E. S. Gaillard has invented a fracture-pin, fig. 443, provided with a silver sheath and brass nut, which is tightened after the instrument is firmly buried in the ends of the fragments. The contrivance does not, apparently, possess any advantages over the screw above described.

14. The method of scraping the ends of the bone, through an open wound, introduced at an early period of the profession, and occasionally practised in modern times, is an inefficient procedure, and should, therefore, be abolished, the more especially as it is not always by any means free from danger.

15. Finally, as a dernier resort, excision of the ends of the fragments, as originally performed in 1760, by Mr. White, of England, may be practised; but it should be borne in mind that the operation is not only difficult of execution, but that it is by no means devoid of danger, more especially when it is performed upon the thigh, where it has occasionally proved fatal. A very free incision is made through the soft parts down to the ends of the broken bone, which are then carefully liberated, brought out at the wound and retrenched, either with a stout knife, a saw, a pair of pliers, or the surgical engine. Sometimes the mere removal of the cartilaginous incrustation is sufficient, an object which may be easily accomplished with a scraper.

To maintain the freshened ends in accurate and steady apposition, it was proposed by Horeau, in 1805, to connect them together by means of wire, retained until the completion of the cure. The procedure has been frequently employed in this country, in consequence, apparently, of the high authority of the late Dr. J. Kearney Rodgers, of New York, who was the first to perform it on this side of the Atlantic. It consists, first, in cutting off the rounded ends of the fragments; secondly, in drilling a hole through each; and, lastly, in tying them firmly together with a silver wire composed of five or six ordinary suture threads, so as to keep them closely and evenly in contact during the consolidating process. It is generally imagined that this procedure is necessarily followed by violent inflammation, jeoparding both limb and life; but this is an error. If the operation be carefully performed, and the after treatment properly conducted, I believe that it will commonly be found to be entirely free from danger, while the utmost confidence may be placed in its efficacy. In nearly every instance in which I have employed it, very little pain, inflammation, or fever occurred, and the result in all, except one, was most satisfactory. The operation is, of course, less dangerous in the upper than in the lower extremity, where, especially if the bone be thickly covered with muscles, it is often attended with great difficulty. When the false joint is situated very high upon the femur such an undertaking is altogether out of the question.

In the first case in which I tried this plan, the fracture occupied the inferior fourth of the shaft of the humerus, and various remedies, among others Dr. Brainard's, had been faithfully but fruitlessly employed. The patient, a man, twenty years of age, being thoroughly anæsthetized, a longitudinal incision, about three inches in length, was carried along the posterior aspect of the arm, through the triceps muscle, over the site of the fracture. The lower fragment was found to overlap the upper about one inch and a half. The ends of the bone were surrounded by a strong fibrous membrane, which was firmly adherent to the neighboring parts, and formed a sort of shut sac, in which the bone was imbedded. About an inch of the lower portion of the upper fragment, and half an inch of the upper portion of the lower fragment, were removed with a delicate saw; but on account of their firm adhesions, and especially the shortness of the inferior piece, some difficulty was experienced in bringing them fully into view. The fragments were conical, rounded, smooth, and invested by a thick, fibrous periosteum: no synovial membrane or fluid existed. The next step of the operation consisted in drilling a hole into each extremity of the bone with a common gimlet, when a piece of wire was introduced to maintain them in apposition. The ends of the wire were twisted together, and allowed to protrude from the wound, the edges of which were approximated by three sutures and adhesive strips. Two splints and a roller being applied, the arm was firmly supported in a sling. There was very little hemorrhage, and no vessels required ligation. As the patient suffered great pain, a grain of morphia was given immediately after the operation. Very little local or constitutional disturbance followed, and nearly the whole wound healed by the first intention. At the end of the eighth week, the union had advanced so far that there was scarcely any perceptible motion. In a fortnight after, the wire was removed,

and the patient went home perfectly restored, the arm being about an inch and a half shorter than the sound one. Under the influence of frequent passive motion, the elbow-joint was gradually regaining its functions.

In another case, that of a man, thirty-two years of age, I treated with equal success, by an operation of this kind, an ununited fracture of the humerus of twenty-seven months' standing. The ends of the fragments were connected by two silver wires, which were permanently retained. The case is reported at length in the North American Medico-Chirurgical Review for July, 1861.

In performing excision, it is very important that the periosteum should not be stripped off the ends of the bone. In a case in which this accident happened to me through the carelessness of an assistant, violent erysipelas with some necrosis was the consequence, endangering the safety of both limb and life.

Professor Henry J. Bigelow, in 1867, published the results of eleven cases of ununited fractures, successfully treated, with one exception, by connecting the excised extremities of the bones with silver wire, great care being taken to preserve the periosteum; a precaution to which he very justly attributed much of the happy effects of the operation.

The results of some of the above operations have been placed in a striking and interesting light by the statistics of Professor Agnew. Thus, of fifty-three cases in which manual friction was used, twenty-five were cured. Of eighty cases treated by mechanical appliances, fifty-seven were cured, and two died. Of seventy-three cases in which the seton was used, twenty-seven were cured, and two died. Of forty-nine cases of immobilization, twenty-seven were cured, and one died. Of one hundred and seventy-eight cases of resection, with its modifications, one hundred and four were cured, and eleven died. Of one hundred and eleven cases of drilling, with its modifications, sixty were cured, and one died. It is worthy of remark that the treatment by the seton is more successful in fractures of the femur and humerus than in those of any other bones. The danger of the more severe operations, especially the seton and resection, follows the same laws as in amputations, increasing with the size of the limb and its proximity to the trunk. Of the seventeen deaths, eight occurred after resection and drilling of the ends of the bone in ununited fractures of the femur; and the operation should, therefore, always be performed with the utmost care.

Whatever plan of treatment be adopted, it is impossible to be too attentive during the after-management of the case, especially in securing repose and accuracy of apposition to the ends of the fragments. As soon as the immediate effects of the operation have passed off, the limb should be incased in the immovable bandage, with an opening opposite the wound for facilitating drainage, and the patient should be permitted to exercise in the open air upon crutches, if the fracture be seated in the lower extremity; the general health should be properly cared for, and every means employed to assist nature in her efforts in effecting a cure. In incurable cases of ununited fracture, or in a false joint consequent upon fracture, the patient will derive great comfort from wearing the admirable contrivance devised for this purpose by Dr. Henry H. Smith, of this city. The apparatus, delineated in fig. 444, is constructed upon the same principles as the ordinary club-foot apparatus, consisting of a shoe, and of a leg and a thigh-piece, connected by hinges, and fastened round the limb by straps and buckles.

If any of the more severe operations are performed, the treatment, for the first few days, must be strictly antiphlogistic, the patient being most carefully watched, lest the inflammation, running too high, produce fatal consequences. If abscesses form, they should be promptly opened, and the utmost attention should, throughout, be bestowed upon cleanliness. The great danger to be apprehended after such operations is from erysipelas, pyemia, and phlebitis.

When all the known remedies, after a thorough trial, fail, and the limb is utterly useless, the only resource is amputation. Few cases, however, demanding such a terrible alternative, will be likely to arise in the present state of the science.

Fig. 444.
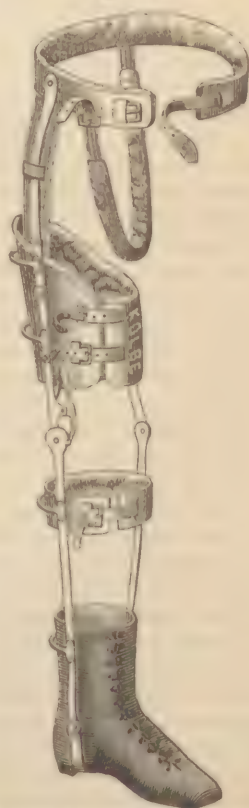
Smith's Apparatus for Ununited Fracture, modified by Kolbé.

7. VICIOUS UNION OF FRACTURES.

From inattention of the surgeon, or a want of coöperation of the patient, the ends of a broken bone sometimes unite in a very unseemly and injurious manner, entirely at variance with the beauty and usefulness of the affected limb, as represented in fig. 445. The deformity thus arising may be produced by the overlapping of the extremities of the fragments, attended, of course, with corresponding shortening; or, it may be owing to the imperfect contact of the two ends, thus occasioning a certain amount of angular displacement, without any abbreviation of the length of the bone. In whatever way the deformity may be induced, it is obvious that it should be rectified at the earliest possible moment; for the longer a case is permitted to remain on hand, the more difficult it will be to afford relief. There are
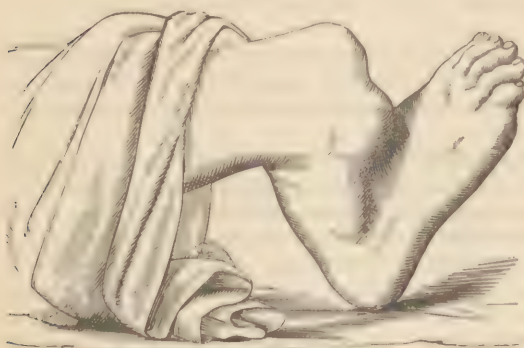
Fig. 445.

Viciously united Fracture of the Leg.

several procedures by which this object may be attained: 1st. Compression and extension; 2dly, forcible flexion, or rupture of the callus; 3dly, subcutaneous division of the connecting medium; and, lastly, resection of the ends of the fragments. These methods are not, of course, all equally adapted to every case.

1st. The safest as well as the most simple procedure, but one which is applicable only in the more early stages of vicious union, consists in applying pressure opposite to the seat of the deformity, in the direction of its convexity. This may be efficiently done by means of appropriate splints and bandages, or with special apparatus provided with pads and screws, and appliances for making extension and counterextension, particularly if there is marked shortening. It is not necessary to give any description of these contrivances, as they may be readily fabricated by any ingenious mechanic, or even by the surgeon himself. No preliminary treatment will be required. It is absurd to suppose that the callus may be softened by cataplasms and fomentations. The compression and extension should be made, at first, in as gentle a manner as possible, and be gradually increased and steadily maintained up to the point of easy tolerance, being occasionally intermitted if productive of pain, or likely to induce excoriation.

2dly. If the preceding method fail, or is inapplicable, forcible flexion and extension, or rupture of the callus, may be attempted, compelling the displaced fragments to retrace their steps. This plan is also chiefly applicable to recent cases, but has occasionally been employed at the end of six, eight, ten, or even twelve weeks. I have myself successfully employed it at the expiration of the second month, and repeatedly within the first three weeks. It would be difficult to state when it should be refrained from; much will necessarily depend upon circumstances, for in one case the union may be firm in a month, while in another, perhaps, equally simple, if not more so, twice or thrice that period may elapse before it is consolidated. Perhaps as good a guide as any would be the existence of slight mobility between the ends of the fragments; if the union is very strong, the attempt to break it might be attended with fracture of the bone above or below the seat of the callus, thus seriously complicating the case. Besides, the operation, except in the more simple forms of the affection, should not be undertaken without some preparation of the system, as it is occasionally followed by violent inflammation, erysipelas, abscess, and even death.

The operation is easily performed, before the union is consolidated, simply by bending the limb over the knee, or by placing it upon a table, and applying pressure upon the distal extremities of the fragments. When the case is of long standing, and the union firm, the callus can only be broken by the employment of force applied by some special apparatus, designed either to act directly upon the callus, or by means of a weight appended to the distal extremity of the bone, the fractured part projecting slightly over the edge of the table, while the portion of the limb containing the upper fragment is carefully held down by assistants. One of the best of the various contrivances devised for this purpose is that of Butcher, fig. 446, the force of which can be made to bear

directly upon the displaced angle of the broken bone. It has been ascertained by experiments, performed by Jacquemin, Bosch, Œsterlen, and others, that the callus of a thigh-bone, broken fifty days previously, requires a weight of fifty to sixty pounds to sever the fragments at the seat of the callus.

3dly. When the union is complete, and the preceding methods have either failed or are inapplicable, partial division of the bone should be practised, the object being to weaken it in such a manner as to admit of its more ready fracture, or gradual bending by systematic compression, as the new osseous matter becomes softened from the effects of the inflammation consequent upon the operation. The perforation is effected subcutaneously by means of a suitable drill, or, what is better, a very narrow chisel. If it be intended to break the bone, this should be done at once, and the limb immediately placed in a suitable apparatus. If, on the other hand, the rectification is to be effected by bending, no formal measures, for this purpose, should be adopted for the first eight or ten days, or until the osseous tissues have undergone a certain amount of softening.

4thly. Other means failing, the only resource is excision of the bone at the seat of the fracture, along with a portion of the callus. The procedure, which took its rise in the early part of the sixteenth century, consists in exposing the extremities of the broken bone, and removing, with the saw or pliers, a sufficient piece to admit of the accurate coaptation of the raw surfaces. The case is afterwards treated as one of ordinary compound fracture.

Finally, when relief is impracticable by any of the means now described, and the limb is

Fig. 446.

Butcher's Clamp for Refracturing badly set Bones.

sadly in the way of comfort and usefulness, the individual being, perhaps, obliged to labor for his daily subsistence, the only alternative is either to abandon him to his fate or to resort to amputation.

In 1851 I met with an instance of compound fracture of the tibia, in a young man of nineteen, in whom about two inches of that bone, near its middle, had been shot away, two years previously, by a rifle ball. The fibula had remained intact, but with the aid of a stiff leather splint, forming a case which reached from just below the knee to within a short distance of the ankle, progression was performed with tolerable ease, although not without the use of a crutch. If the deficiency of bone had been somewhat less, I should have been tempted to cut away a portion of the fibula, and, after refreshing the ends of the tibia, to approximate the bones by means of splints, or silver wire, fully anticipating a good cure. Since this suggestion was thrown out, many years ago, this treatment has been carried into effect by the Professors Pancoast, who have reported several successful cases. Instead, however, of exsecting a portion of the fibula, they simply broke that bone opposite the fracture in the tibia.

8. DISEASES OF THE CALLUS.

Callus, like all new tissues, is liable to different diseases, both during its development and after its completion, more or less hostile to its welfare and perpetuity. Some of these affections have a local origin, some depend upon the state of the constitution, and others, again, seem to partake of the nature of both of these. Deficiency of callus, although not, properly speaking, a disease, may, nevertheless, become a source of great difficulty on account of its inability to subserve the purpose of a supporting medium. The causes which may induce this condition, and the means of remedying it, when it exists, have already been pointed out.

An exuberant callus is by no means uncommon; it occasionally arises without any obvious cause, but more generally it is dependent upon the separation of the ends of the broken bone, as if nature were determined to effect union, despite the neglect of the sur-

geon.   The annexed cut, fig. 447, from a drawing of a specimen in the collection of the late Professor Cobb, of the University of Louisville, affords a graphic illustration of an excess of this substance, obviously produced in this way.   The fracture, an oblique one, situated just above the middle of the right femur, had evidently occurred several years
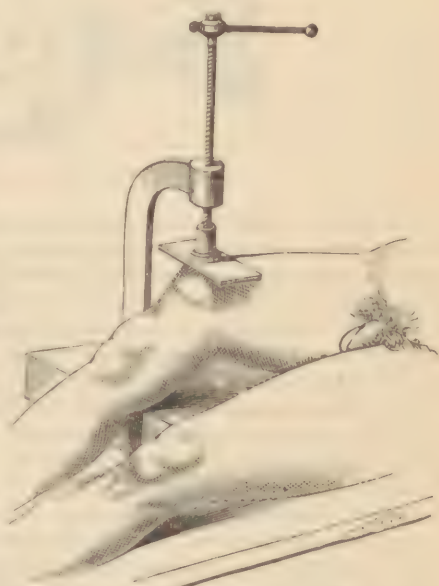
Fig. 447.
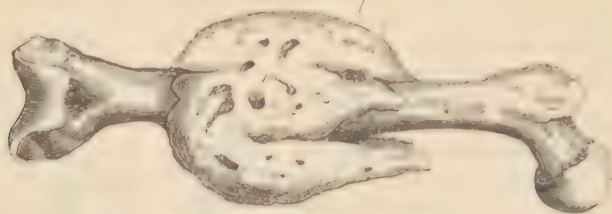
Exuberant Callus after Fracture of the Thigh.

before death.   The callus, which was exceedingly porous as well as very brittle, was eleven inches in circumference at the widest part, by six inches in length.   From its superior extremity projected two processes, which overlapped the upper fragment, and must have materially impeded the action of the muscles of the limb.

An exuberant callus is occasionally produced by the presence of pieces of dead bone, which it thus imprisons as foreign bodies are sometimes inclosed by a cyst, or by a wall of plastic matter.   The sheath thus formed, however, is always imperfect, openings existing in different parts of its extent for the purposes, apparently, of drainage.   Neglected or badly-treated comminuted fractures, caused by gunshot, railway, and other severe injury, are not unfrequently followed by an extraordinary redundancy of callus; and as the effect of this substance is to incarcerate the fragments of the broken bone, profuse discharge, generally of an unhealthy, fetid, and sanious character, may be thus kept up for almost an indefinite period.   The proper remedy, obviously, is the extraction of the dead fragments, a procedure occasionally of a very embarrassing character, especially when the callus is situated in a bone thickly covered by muscles, or in close proximity with important vessels and nerves.   In a case under my charge many years ago, I removed not less than twenty-four pieces of this kind, some of considerable size, having previously made a long incision over the tumor in front of the thigh.   With the aid of chisels, gouges, and pliers, riddance was achieved with but little loss of blood, and with no pain, as the patient was thoroughly under the influence of chloroform.   Although the number of dead pieces was unusually great, such was the size and firmness of the callus that, notwithstanding it was obliged to be divided in almost every direction, no separation of the ends of the broken bone ensued, and the patient, after having recovered from the immediate effects of the operation, was able to walk about as before.   The fracture had been caused nine months previously by an escapette ball.   When exuberant callus exists in its more simple forms unaccompanied by dead bone, its removal may occasionally be effected by the persevering inunction with compound iodine ointment and other sorbefacient remedies.

An extraordinary degree of brittleness, arising from an excess of earthy matter, occasionally exists in the callus of a broken bone.   Such an event may occur at a comparatively early period, as a result of causes the true nature of which is not always easy of detection.   I believe, however, that fragility of the callus is more frequently met with in persons of a gouty, rheumatic, or syphilitic state of the system, than in any other class of individuals.   However induced, the slightest injury, as a mere twist of the bone, or even muscular exertion, is generally capable of fracturing it, and, consequently, of reseparating the ends of the fragments.

Callus is subject to *softening*, disintegration, and absorption, if not, also, to fatty degeneration.   The causes under the influence of which these changes are affected are not always, or, perhaps, even generally, distinguishable.   In some cases they are plainly owing to undue compression, as from tight bandaging; in others, they are induced by premature exercise, or the weight of the body causing undue pressure upon the callus.   Occasionally, the absorption is distinctly traceable to the inordinate use of mercury, carried to profuse salivation; or it may depend upon a syphilitic taint of the system, especially when this affection has reached its third stage, in which the bones and periosteum are so constantly, and often so seriously, involved.   But the most common cause, perhaps, of all, is an impoverished and diseased state of the blood, from a want of proper food and fresh vegeta-

bles and subacid fruits.   The influence of ill-health arising from this cause upon the condition of the callus was strikingly exemplified in Lord Anson's voyage to the Pacific Ocean, in which many of the crew suffered severely from scurvy.   It was noticed that those who had formerly had fractures were attacked with absorption of the callus, speedily terminating in separation of the ends of the broken bone.   Cicatrices, whether the result of the healing of wounds or of ulcers, experienced a similar fate, the parts breaking out into open sores, remarkably pale, languid, flabby, and difficult to cure.   Similar effects are occasionally observed to follow the attacks of typhoid fever and anemic states of the system, however engendered.

The treatment of softened and disintegrated callus must depend upon the nature of the exciting cause, due inquiry into which should, therefore, always be made as a preliminary step.   Tight bandages and splints are removed ; premature exercise is avoided ; iodide of potassium and mercury are administered if the cause is obviously of a syphilitic nature ; scurvy is relieved by a change of diet, especially by the use of subacid fruits and vegetables ; and anemia is met with tonics and stimulants, as iron and quinine, with milk punch and nutritious food.

Finally, callus is sometimes the seat of severe pain, generally of a dull, aching character, but occasionally very sharp, and recurring at every change of the weather, so that the part literally subserves the purpose of a barometer.   Persons of a gouty, or rheumatic predisposition, and those affected with tertiary syphilis, are particularly prone to suffer in this way.   Now and then the pain appears to be of a neuralgic nature.   The most accurately united fracture may be followed by such an occurrence, but it is by far most common in those in which there is a redundant or very irregular callus.   The cause of the pain has been variously explained.   The probability is that it is generally due to the pressure exerted by the exuberant substance upon the nerves in its immediate vicinity. This idea appears the more plausible when it is recollected that filaments of nerves of considerable size are sometimes imprisoned in the callus of a broken bone.

Among the more important remedies for the relief of this pain, are various sorbefacient and anodyne lotions, as acetate of lead and laudanum, tincture of iodine, chloroform liniment, and veratria ointment.   Sometimes a blister answers a good purpose.   When the pain is dependent upon a syphilitic taint of the system, the iodides must be employed, either alone or in union with mercury.   Colchicum will be useful when there is a gouty or rheumatic state of the system.   Excision of the callus might be required when it is obvious that the suffering is due to the presence of a compressed and imprisoned nerve.

SECT. XX.—FRACTURES OF PARTICULAR BONES.

1. HEAD AND TRUNK.

FRACTURES OF THE NASAL BONES.

Falls and blows are the causes of this fracture, which may be either simple or complicated ; oblique, transverse or longitudinal ; limited to one bone or extended over both. It is usually attended with severe injury of the soft parts, and sometimes with fracture of the ascending process of the superior maxillary bone.   Occasionally, again, there is a separation of the nasal cartilages, or fracture of the ungual bone, the ethmoid bone, the vomer, or the turbinated bone.   The symptoms are generally well marked, except when there is considerable swelling of the integument, when the nature of the lesion may easily be overlooked, perhaps much to the detriment of the patient.   If an examination be made soon after the occurrence of the accident, the nose will be found to be out of shape, from displacement of the fragments, one of which may be depressed towards the nostril, while the other may form an unusual prominence beneath the skin.   Crepitation is also commonly distinguishable, especially when the fracture is multiple, or the bone is broken into several pieces.   In all cases, the point of the finger should be passed over the surface of the nose, with a view of ascertaining whether there is any irregularity or mobility, as there will almost certainly be when there is a fracture.   If, after this, there be still some doubt, it will be well to introduce a large probe, metallic bougie, or grooved director into the nostril, for the purpose of making counterpressure, while pressure is applied in the opposite direction with the end of the finger.   When the bone is denuded by a wound, the diagnosis will seldom be difficult.

More or less bleeding generally attends this accident ; occasionally, indeed, it is very profuse, and in some instances it is said to have proved fatal.   Another symptom, some-

times present, is emphysema at the root of the nose, extending along the eyebrows. It usually comes on within a short time after the accident, and is owing to an escape of air from the nostril across a rent of the mucous membrane into the subcutaneous connective tissue. It is in itself of no moment, as it usually disappears spontaneously in a few days. An escape of tears is also an occasional occurrence. Sometimes violent cephalic symptoms attend these fractures, depending upon the intimate connection between the nasal and frontal bones, which permits the jarring effects of the blow or fall to be communicated to the brain and its envelops.

Fracture of the nasal bones is not always free from danger, although the patient generally recovers without any untoward symptoms. Danger to life is to be apprehended only when there is serious cerebral involvement, as when the lesion is associated with fracture of the cribriform plate of the ethmoid bone, separation of the dura mater at the anterior part of the base of the skull, copious effusion of blood, or severe concussion of the brain. Under such circumstances, the patient may die from shock, compression, or inflammation. The prognosis should, therefore, be guarded, especially as the degree of danger cannot always be estimated by the amount of visible injury. If the fracture is multiple, or the bones are crushed in, more or less deformity may be expected after the cure.

The *reduction* is generally easy. The patient being seated upon a chair, with his head reclining against the breast of an assistant, any depression that may exist is to be remedied by means of a female catheter or grooved director, inserted into the nostril, and made to bear against the displaced fragment until it resumes its proper level. Sometimes a good deal of pressure and counterpressure will be necessary, while at other times hardly any manipulation will be required, the mere passage of the finger over the seat of the fracture being sufficient to adjust the fragments. When the nasal septum, or perpendicular plate of the ethmoid bone, is thrown out of place, restoration may be effected by means of the finger, or some suitable instrument, introduced into the nostril.

When the fragments have a tendency to cave in, or to fall asunder, the best means of counteracting it is a stout adhesive strip, carried across the bridge of the nose from one cheek to the other; the plaster promptly adheres to the skin, and, assuming the shape of the nose, effectually prevents further displacement. Or, instead of this, the depressed fragments may be supported, as suggested by Dr. Lewis D. Mason, by means of a sharp, three-cornered, nickel-plated needle passed through the line of fracture, and retained with a lightly applied rubber band stretched across the bridge of the nose, and secured to the ends of the instrument. The older surgeons were in the habit in such cases of stuffing the nostrils with dossils of lint, smeared with ointment, and frequently changed for the sake of cleanliness. Subsequently, metallic tubes were recommended, and in modern times tubes of gum elastic have been used. All such contrivances are now very properly discarded; or, if they are ever employed, it is only in cases where it is impossible, from the manner in which the bones have been crushed, to remedy the displacement in any other way. During the whole of the after-treatment the patient should refrain from blowing his nose.

The symptoms which usually follow this accident, such as inflammation of the pituitary membrane, fetid discharge, and swelling of the nose and face, are combated by general and local bleeding, purgatives, and other antiphlogistics. The brain is carefully watched, and any untoward occurrence promptly met. Hemorrhage is restrained by cold applications, and elevation of the head and arms; if obstinate by plugging the nostrils, or by injections of a strong solution of subsulphate of iron. In neglected cases of this injury a not uncommon occurrence is deformity caused by the irregular projection of some of the fragments. In an instance of this kind, recently under my charge, the nose was restored to its natural form by rasping away the offending and superfluous matter with the aid of a dentist's engine.

FRACTURES OF THE NASAL CARTILAGES.

The nasal cartilages are sometimes broken, or broken and partially detached from the nasal and maxillary bones, the most common cause of the accident being a violent blow or fall, inflicting, perhaps, at the same time serious injury upon the soft parts. The nature of the case can seldom be mistaken. When the cartilages are displaced inwards, the nose will necessarily be more or less flattened and depressed, and the effects will assume increased importance, if the lesion be conjoined with fracture of the nasal bones and the cartilaginous septum. The treatment must be conducted upon general principles. The great aim should be to preserve the contour of the nose; hence, after having restored the parts to their proper relations, it may be necessary to plug the nostrils with

lint, well oiled, a metallic tube or piece of quill having previously been inserted to facilitate respiration. Leeches may be required to moderate inflammation.

In the case of a man, forty years of age, brought to the Clinic of the Jefferson Medical College, by Dr. McWhinney, the septum, broken into several pieces four months previously, encroached so much upon the left nostril as to cause almost complete obstruction to respiration on that side. In order to afford relief, I was compelled to cut away the whole of the offending part with a probe-pointed bistoury. The nose seemed to have been very little deformed by the accident.

Dr. Bolton, of Richmond, in a case of old displacement of the nasal septum, effected restoration by an ingenious process, consisting of a stellate incision made in such a manner as to form eight triangles with their apices converging to a common point. He then seized the triangles separately with a pair of forceps, and broke them at their base without detaching them. The comminuted part was next forced into its natural position and supported by appropriate dressings in the nostrils until union occurred.

FRACTURES OF THE UPPER JAW.

A fracture of the upper jaw implies the application of direct mechanical injury, in a concentrated and severe form. No ordinary force could produce such a result. In a few instances it has been caused by contre-coup, the head and lower jaw being wedged in between two hard, resisting bodies. Portions of the alveolar process, of variable shape, and even of large size, are sometimes broken off in the extraction of a tooth. There is nothing definite at all in regard to the situation of the fracture, since it may affect any portion of the bone, its body, ascending process, horizontal plate, or alveolar process. It is always accompanied by severe injury of the soft and hard parts, and is usually of easy recognition, simple inspection, or touch, commonly sufficing for the purpose. The accident is apt to be followed by violent inflammation, requiring prompt measures for its relief.

In the reduction, pressure and counterpressure are chiefly relied upon, the parts being moulded gently into their natural position by the fingers, either alone, or aided, as in fracture of the horizontal plate of the bone, by the grooved director inserted in the nostril. If the alveolar process has suffered, it may become necessary, in order to secure its proper maintenance, to tie together several of the contiguous teeth with thin silver wire. Whatever may be the nature of the case, the rule is, if possible, to save all, and take away nothing.

In 1865, I attended, along with the late Dr. Smiley, a man forty-seven years of age, who had broken the left upper jaw in falling head foremost from the third-story window of his house upon the cellar-door below, a distance of about thirty-five feet. He was much stunned by the blow, and it was not until after he had freely vomited, seven hours after the accident, that entire consciousness was restored. The face and forehead were greatly bruised and discolored, the nasal bones were comminuted, the left eye was ruptured, a considerable quantity of blood escaped from the nose and mouth, and the jaw was broken in such a manner that it could easily be moved about in different directions with the fingers. The line of fracture extended from behind forwards between the cuspid and small grinder, but none of the teeth were knocked out or even loosened. Notwithstanding the severity of the injury, the man rapidly recovered, with hardly any perceptible deformity, except what was caused by the state of the eye. For the first few weeks there was great difficulty in swallowing, and several months elapsed before solid food could be masticated. The treatment was very simple. Until the eighth day the principal remedies were anodynes, laxatives, and saturnine lotions. When the inflammation and swelling had measurably subsided, the head was carefully bandaged in such a manner as to keep the lower jaw in constant contact with the upper until the parts were thoroughly reunited.

FRACTURES OF THE MALAR BONE.

Fracture of the malar bone, as an uncomplicated lesion, is very uncommon. Like fracture of the upper jaw, it is always produced by direct violence, is invariably attended with severe contusion, if not with other injury of the soft parts, is, in general, readily recognized, is liable to be followed by high inflammation, and is easy or difficult of management according to the presence or absence of displacement. When the broken part is sunk down beyond its natural level, an attempt may be made to raise it, especially if there is already a wound denuding the bone, and admitting of the insertion of a suitable lever; if not, an incision is made, provided it seems probable that there will be unsightly

deformity after the cure, if the fragment be left in its abnormal situation. Such a procedure is much better than leaving the bone unreduced.

In fractures of the zygomatic arch of the malar and temporal bones, the fragments, as a rule, are forced backwards, and hence the deformity is sometimes very considerable, calling for reposition with an elevator. In a case recorded by Duverney, and in another mentioned by Packard, the displacement took place in a forward direction.

FRACTURES OF THE LOWER JAW.

The lower jaw bone may be broken in any portion of its extent, not excepting even the symphysis. Fracture here, however, is unusual, and is met with chiefly in young subjects, before the complete union of the two opposite halves of the bone. The most common site of fracture is the body of the maxilla, towards its anterior extremities, as in fig.

Fig. 448.
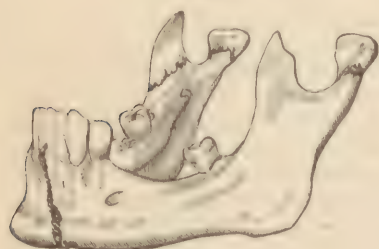
Fracture of the Jaw.

448, and next in point of frequency, at least according to my observation, its ascending ramus. The condyle, neck, and coronoid process are seldom broken. The fracture may be transverse, oblique, or longitudinal; single or multiple; simple or complicated. When the bone yields at two points, there will necessarily be three fragments, and cases occur in which the number is still greater, the bone being literally crushed. Thus, Houzelot has published the particulars of one in which the bone was broken, in a fall from a height, at both condyles, through both coronoid processes, and at the symphysis. Sometimes the lesion is limited to the alveolar process, or to this process and the body of the jaw. In either event, there will be involvement of the gums and teeth, with, perhaps, extensive separation, if not complete evulsion, of the latter. Occasionally, a longitudinal fracture of the body of the bone is intersected at each extremity by a transverse or an oblique one. The accident, which rarely occurs before the age of manhood, is much more frequent in males than in females. When the ends of the fragments are unusually long and sharp, they may, if the parts are not well supported, pierce the mucous membrane, thus converting a subcutaneous into an open fracture.

Direct violence, as a fall, blow, or kick, is the most common cause of fracture of the inferior jaw. In four instances, under my charge, it was produced by a blow with the fist upon the chin or side of the bone, one of the cases being a healthy lad, between fifteen and sixteen years of age; the others, persons between twenty-five and thirty-two. A very common cause of this fracture is the kick of a horse. Dentists often break off portions of the alveolar process in the effort to extract teeth. Sometimes frightful injury is produced in this way. Muscular action is capable of breaking the lower jaw. A man, upwards of seventy years of age, an out-patient at the College Clinic, presented himself to the late Professor Pancoast in January, 1857, on account of a fracture of the neck of this bone, caused the night before in a violent paroxysm of coughing. The symptoms were unmistakable. The explosion of powder in firing off a pistol within the mouth has also been known to give rise to the accident. Finally, the lower jaw is sometimes broken on one side from a blow upon the opposite, or by counterstroke, as in a case related by Dr. Cockburn, in which the bone yielded at its neck.

The *symptoms* of fracture of the body of the lower jaw are generally so well defined as to render it easy of diagnosis. Crepitation may almost always be detected by moving the fragments; and upon looking into the mouth the teeth will usually be found to have lost their natural relations. There is also commonly a perceptible inequality at the inferior border of the bone, which may readily be increased by motion, and which is of itself sufficient to point out the character of the injury. When the jaw gives way on both sides, the central piece is drawn downwards by the muscles of the throat, the front teeth are out of their normal position, and the mouth is open and distorted.

In fracture of the ramus there will be a grating noise at the site of the injury, and excessive pain near the ear. From the fact that the masseter muscle is attached to, and covers in, both fragments, there is seldom, if ever, any considerable displacement.

A fracture of the neck of the bone is easily detected, except in very fat subjects, by the crepitation produced on moving the jaw, by the preternatural mobility in front of

the ear, and by the manner in which the body of the bone is dragged forward by the action of the external pterygoid muscle. Similar symptoms characterize fracture of the condyle.

In addition to the symptoms now described as indicative of fracture of different portions of the inferior maxilla, there will be more or less impediment in speaking and swallowing, difficulty in opening and closing the mouth, and inability to masticate. The patient experiences severe pain at the seat of fracture, aggravated by motion and manipulation ; the soft parts are usually considerably contused, if not also lacerated ; and there is often smart hemorrhage, either from rupture of the mucous membrane or of the inferior dental artery.

Simple fractures usually unite in from four to five weeks, without ultimate deformity or functional impediment. Those of the neck of the bone require a longer time, and more care in their management, than those of the body and ramus. Complicated fractures of the jaw are often followed by severe suffering, caused either by inflammation, abscess, caries, or necrosis. Great emaciation sometimes arises from the inability of the patient to take sufficient nourishment during the long confinement of the parts.

During the *reduction* of these fractures, the patient should be seated upon a chair, with his head firmly supported upon the breast of an assistant. The surgeon, passing his fingers along the base of the jaw, supposing that it is the body that is broken, moulds the parts into proper shape, and then, closing the mouth, sees that the lower teeth rest fairly against the upper. When the fragments overlap each other, they must be drawn in opposite directions, when the slightest pressure will generally suffice to effect their restoration. If any of the teeth are loosened, or partially forced from their sockets, and they are perfectly sound, they should by all means be retained, being secured, if need be, to the adjacent ones, by a silver wire. Formerly it was the custom to treat all such teeth as extraneous bodies, under the erroneous belief that they were incapable of readhesion.

The fracture being reduced, as may always be known by the evenness of the dental arch and of the inferior margin of the jaw, a piece of pasteboard, or, what is preferable, of felt, fig. 449, immersed in hot water, is accurately moulded to the base and sides of the jaw, and, after being well lined with wadding, confined by a roller carried round the top of the head in the form of the figure 8, one portion of the bandage lying in front, the other behind the ears. The lower jaw being thus pressed firmly against the upper, the bandage is next conducted across the chin and the occiput above the ears, so as to give the fragments due support in front. This mode of dressing is very simple and efficient, and generally answers the purpose exceedingly well. When any unusual tendency to anterior displacement exists, it may readily be counteracted by a stout adhesive strip, extending from the chin along the lower part of the face to the side of the occiput. The annexed cuts, figs. 450 and 451, represent the bandages of Gibson and Barton, formerly so much

Fig. 449.	Fig. 450.	Fig. 451.
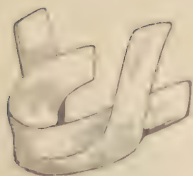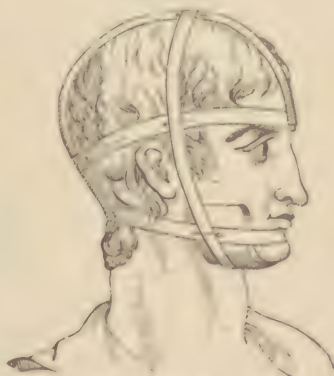
Felt Mould.   Gibson's Jaw Bandage.   Barton's Jaw Bandage.

employed in this country in the treatment of fractures of this bone. Instead of the felt or pasteboard splint, a mould of sheet lead may sometimes be advantageously used, as it readily adapts itself to the parts, and affords steady, uniform support. Recently I had under my charge a case of fracture of this bone, unattended with displacement, where a rapid and perfect cure was effected without any dressing whatever.

Professor Hamilton, in the treatment of fractures of this bone, employs an apparatus consisting of three straps, one of which, composed of firm leather, extends round the jaw

and head in the direction of the coronal suture, while the other two, made of strong linen webbing, pass horizontally round the head, above the ear, the anterior being buckled to the forepart, and the posterior to the backpart, of the vertical one. The great advantage of this contrivance, represented in fig. 452, is the strong support it gives to the ends of the fragments, thus effectually preventing displacement.

Instead of confining the splints or moulds used in the treatment of fractures of the lower jaw with the ordinary roller, a great point is gained by using the

Fig. 452.

Hamilton's Apparatus.

Fig. 453.
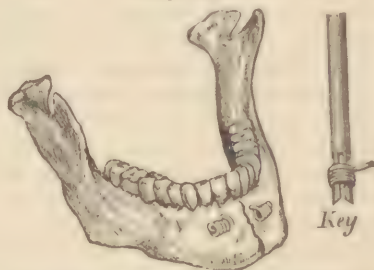
Thomas's mode of adjusting Fractures of the lower Jaw with wire and key.

immovable bandage, the hair previously been cut very close, and the head covered with a layer of wadding or thin flannel. Such a bandage, properly applied, keeps the parts effectually in position until complete union is obtained.

In fracture of the neck and condyle of the jaw, maintenance is always peculiarly difficult, on account of the action of the external pterygoid muscle. The most effective means of counteracting this tendency is to confine a thick, graduated compress behind the angle of the bone, the case being treated, in other respects, as if it were one of fracture of the body of the jaw.

In comminuted fracture, it is sometimes exceedingly difficult, if not impossible, despite the best directed efforts, to keep the fragments on a level with each other, such being their constant tendency to displacement. To rectify this tendency, the contiguous teeth should be connected together with delicate silver wire; or, what is better, because more efficient, some of the teeth may be secured to a thin silver plate, interposed between them and the checks. Mr. Tomes, of London, has suggested the use of a silver cap for the teeth, and Mr. Hugh O. Thomas, of Liverpool, connects the fragments together with silver wire, secured with a key, as in fig. 453. Mr. Hammond's ingenious contrivance also answers an excellent purpose. It consists of a frame of iron wire, fig. 454, which is slipped over the teeth, and fastened by passing around each a thin iron thread, as a

Fig. 454.

Hammond's Wire Splint for Fracture of the Jaw.

Fig. 455.
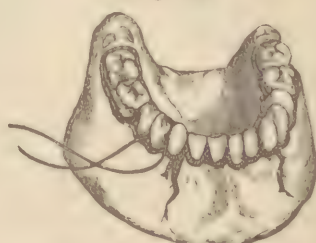
Hammond's Wire Splint applied.

binder, to keep the frame firmly in its place, as shown in fig. 455. The operation is completed by cutting off the ends of each thread, and turning them in between each two contiguous teeth, so as not to interfere with the movements of the lips and checks. Occasionally it is necessary to take a plaster cast of the jaw as a preliminary step.

The interdental splint, devised nearly at the same time by Dr. Gunning, of New York,

and by Dr. Bean, of Georgia, is adapted to fractures both of the upper and lower jaw, particularly to comminuted and compound fractures, attended with inordinate and constant tendency to displacement of the fragments. The only objections to its employment are, that it is somewhat expensive, and that it cannot always be readily obtained. The splint, as seen in fig. 456, consists essentially of a plate of vulcanized India-rubber, accurately moulded by means of a wax or plaster impression to the dental arches, and kept in position by a chin compress of the same material, fastened by an occipito-frontal bandage. In this way the most complete adjustment can be maintained without inconvenience to the patient, and, if the apparatus be properly constructed, without the slightest deformity, except in the event of great loss of bone. A good idea of the external parts of the apparatus is afforded by the annexed sketch, fig. 457.

Fig. 456.

Fig. 457.

Bean's Interdental Splint.

Interdental Splint, applied.

In edentulous subjects, a mould of hard rubber, constructed after the manner of the plate for artificial teeth, should be interposed between the two jaws. In no other way, in fact, can the ends of the fragments be maintained in apposition. Wedges of cork, recommended by some surgeons, are highly objectionable, as, from their porous character, they readily imbibe the secretions of the mouth, and thus become a source of fetor, if not of disease.

Wounds, contusions, and hemorrhage, complicating these fractures, are managed upon general principles; inflammation is combated by the usual measures; loosened teeth and necrosed bone are promptly removed; and the parts are kept steadily at rest, renewal of displacement being guarded against by the most sedulous attention both of the patient and the surgeon. The food should consist of slops, as grated cracker and milk, broths, gruel, beef essence, and similar articles, introduced into the mouth with a small spoon. The custom which formerly prevailed of conveying nourishment into the stomach by means of a tube passed through the nose, has become obsolete, as well as the still more reprehensible practice of extracting one of the front teeth, to afford room for feeding the patient. After the case has advanced for several weeks, a semisolid, farinaceous diet may be allowed.

In compound and comminuted fractures of the lower jaw, especially in those caused by gunshot injury, the secretions of the mouth and of the salivary glands are always excessively foul and abundant, and are liable, if swallowed, to give rise to a low, typhoid condition of the system; in fact, to a bad form of septicemia, followed gradually, if not soon relieved, by death. In order to prevent such an occurrence, the greatest attention should be paid to cleanliness, the mouth being frequently washed with lotions of chlorinated sodium, alcohol, or permanganate of potassium, abscesses promptly opened, dead bone removed, and the strength supported with quinine, iron, opium, and alcoholic stimulants.

An instance of ununited fracture of this bone is sometimes met with, and now and then a false joint is found to exist, requiring, in the former case, the employment of ordinary measures, and in the latter, denudation of the ends of the fragments, aided, perhaps, by the silver wire suture or the insertion of a metallic pin.

FRACTURES OF THE HYOID BONE.

The hyoid bone, from its great mobility, and from the protection which it receives from the lower jaw, is seldom the seat of fracture. The accident is usually occasioned by falls or blows, or by the pressure of the thumb and fingers in attempts at strangulation. An instance is mentioned where it was produced by muscular action, the patient having fallen violently backwards upon his head. Persons who commit suicide by hanging occasionally break this bone with the rope. The fracture is generally seated in the large horns, sometimes in both, at other times only in one. It is liable to be complicated with injury of the larynx, lower jaw, and other parts, the skin being usually bruised and discolored. The patient is unable to swallow, to articulate distinctly, and to move his tongue, except in the most limited degree, and then not without great suffering, and, perhaps, a sense of suffocation. Crepitation is generally sufficiently evident, especially during deglutition and when the index finger is placed upon the throat in contact with the smaller fragment, the corresponding finger resting upon the neck. The pain is very acute, and is aggravated by the slightest motion. Sometimes the patient is conscious of a peculiar crushing sound at the moment of the accident. Occasionally there is laceration of the mucous membrane of the fauces, followed by copious hemorrhage, as in a case reported by Professor Wood, of Cincinnati.

Fracture of the hyoid bone, although not in itself necessarily dangerous to life, often becomes so in consequence of its complications, death having occurred in 12 cases out of 23 referred to by Fischer, of Hanover. Even in the most simple cases it is generally exceedingly troublesome, on account of the great mobility of the fragments, and the severity of the supervening inflammation and swelling. Occasionally abscesses form, the detached piece becomes necrosed, and the neck is pierced with fistulous orifices, which are slow in healing. The accident has hitherto been noticed chiefly in aged subjects, probably on account of the great brittleness of the bone at that period of life.

In the treatment of this fracture, the head must be inclined forward, and maintained in a state of the utmost quietude, by an appropriate bandage secured around the chest. If there is much displacement, readjustment should be attempted by means of the finger in the throat while counterpressure is made externally. Perfect silence should be enjoined. Pain and swelling are subdued by leeches applied to the neck, followed by saturnine and anodyne fomentations ; the bowels are freely evacuated by stimulating injections, and fever is combated by the usual means. For the first few days, the amount of food and drink should be barely sufficient to sustain life. If the patient cannot swallow, the stomach tube must be used, or nourishment must be administered by the rectum. After the swelling of the neck has measurably subsided, an attempt should be made to keep the fragments in place by compresses and adhesive strips. If necrosis occur, the dead bone should be promptly extracted. In ordinary cases, the fracture will unite in from six to eight weeks.

FRACTURES OF THE CLAVICLE.

The clavicle, owing to the delicacy of its structure, its exposed situation at the top of the chest, and its connection with the shoulder and arm, is extremely liable to break. Of 2358 cases of fractures of different pieces of the skeleton, referred to by Malgaigne, 228 occurred in this bone, and of this number nearly three-fourths were observed in the male, thus exhibiting a remarkable disparity in regard to the relative frequency of the lesion in the two sexes. The accident is not peculiar to any particular period of life ; I have witnessed it in a child under six months of age ; and Dr. W. Keller, formerly of this city, showed me a case in which it had taken place in the fœtus from the fall of the mother upon the wheel of a carriage, at the eighteenth week of gestation. The child, at the time of my examination, was several months old, and the seat of the fracture, which was near the middle of the right clavicle, was indicated by a well-marked forward angular projection of the ends of the fragments, which, however, were firmly united before birth. A similar case was shown to me, in 1861, by Dr. William B. Atkinson, the fracture having been produced by a blow upon the abdomen of the mother at the end of the seventh month of pregnancy. Gurlt has collected the particulars of seven cases of intrauterine fracture of this bone caused by external violence.

Fractures of this bone may be simple, compound, or comminuted ; unilateral or bilateral ; transverse or oblique ; partial or complete. A strictly transverse fracture of the clavicle is among the rarest of accidents, and I have myself never met with an instance

of it, either in the living subject, or in any of the specimens contained in our museums. The bone nearly always gives way obliquely, the ends of the fragments being generally rather long and sharp, and often distinctly serrated. When very sharp, they may pierce the skin, or, at any rate, press against it with so much force as to cause much uneasiness, and not a little difficulty in maintaining apposition. It is very uncommon for the bone to break at several points; such an accident, in fact, can only happen from the application of direct injury. Simultaneous fracture of both clavicles is exceedingly rare. I have two clavicles in my possession, from the same subject, which were broken in the same situation, but whether by the same accident, I am unable to say. Only six instances of the double injury are referred to by Malgaigne. To these may now be added three others, recorded, respectively, by Foucher, Rhoads, and Burr. Of 158 cases of fractures of the clavicle treated in the New York Hospital, 4 were double. The incomplete fracture of this bone is an accident of early childhood, and is of much more frequent occurrence than is generally supposed.

The seat of the fracture is usually at or near the middle of the bone, as it is here that it is thinnest and weakest. Of twelve preparations now before me, it is about this point in eight; in three it is towards the acromial extremity, and in one towards the sternal. Fracture of either end is very uncommon, and I have never met with an instance, either during life or after death.

Great displacement, as shown in fig. 458, generally attends fractures of the clavicle; now and then, however, the broken ends maintain their natural relations, as I have myself noticed in five instances. Such an event can only occur when the fracture is incomplete,

Fig. 458.

Fracture of the Clavicle.

or when the periosteum is only partially divided and there has been no dragging of the shoulder. Generally the outer fragment is drawn downwards, forwards, and inwards, by the weight of the limb and by the action of the deltoid, pectoral, and subclavian muscles; the inner, on the contrary, is usually somewhat raised by the sterno-cleido-mastoid, but not so much as its extraordinary prominence would seem to indicate, its tendency to displacement in that direction being pretty effectually counteracted by the great pectoral muscle and the costo-clavicular ligament. These appearances are well seen in fig. 459. Cases in which the acromial fragment overlaps the sternal, although infrequent, have been witnessed by numerous observers, as Desault, Malgaigne, Guéretin, Syme, Hamilton, and Stephen Smith. In fracture of the extremities of the clavicle, the loss of apposition is usually very slight, owing to the manner in which the bone is attached to the scapula and the sternum. In comminuted fracture, the displacement may be so great as to render reposition impracticable, the middle fragment being occasionally tilted up perpendicularly. When the bone gives way external to the coraco-acromial ligaments, the outer fragment is sometimes turned round at a right angle with the inner.

Fig. 459.

Complete Oblique Fracture near the Middle of the Clavicle.

The accident is generally caused by indirect violence, as a fall upon the hand, elbow, or shoulder, especially the latter, in which the sternal extremity of the bone is impelled by the weight of the body, at the same time that the acromial end is thrust forcibly in the opposite direction by the object struck against. Not unfrequently, however, it occurs from direct injury, as a blow or fall. I have seen two cases in which it was occasioned by the recoil of a shot-gun; and a similar example was reported to me by the late Dr. Herschel Foote, of West Philadelphia. Children often break the clavicle by tumbling out of bed, or by rolling down a flight of stairs. In several instances, as in one recently reported by Dr. W. E. Whitehead, of the Navy, the accident was caused by the inordinate action of the pectoral and deltoid muscles. Gurlt has collected the particulars of twenty cases of fracture of the clavicle produced by muscular contraction. In a case observed by Dr. Willard Parker, it was produced in an effort to strike a dog with a whip, the bone

being slightly diseased at the time. When both clavicles are broken, one generally gives way by indirect, and the other, immediately after, by direct force.

The *symptoms* are generally well marked. The shoulder has a singularly depressed appearance, being drawn downwards, forwards, and inwards by the weight of the limb and the action of the muscles, especially the deltoid and small pectoral ; the head and trunk are inclined towards the injured side ; there is impossibility of rotating the arm, or of carrying the hand to the face ; and the patient commonly supports the elbow in order to take off the weight of the limb from the broken bone. The seat of the fracture is generally readily discovered by the eye, the deformity being nearly always extremely conspicuous ; and the finger, as it traces the outline of the bone, cannot fail to detect any existing irregularity. Crepitation is elicited by taking hold of the elbow and pushing the arm upwards, outwards, and backwards, in a direction opposite to that of the displacement. The same procedure will serve to efface the deformity, which, however, is instantly reproduced upon the removal of the restraint. When the fracture is imperfect, serrated, or unattended with displacement, there is usually an absence of crepitation, and the diagnosis can be established only, as a general rule, by a careful digital examination, aided by the alternate elevation and depression of the shoulder. In such a case the plan suggested by Roberts is worthy of trial. The patient is desired to raise himself upon his two wrists, and, while he does this, the fingers applied to the clavicle readily detect crepitation.

Although the patient is generally unable, in fracture of the clavicle, to carry his hand to the head, I have met with some very striking exceptions to this rule, both in children and adults. In a man, forty years of age, whom I saw with Dr. O'Reilly, this movement could be executed with quite as much facility as with the other limb. He could even swing the limb about without any pain or inconvenience. The fracture, caused by a fall upon the edge of a doorstep, was situated towards the acromial extremity of the bone, and was attended with marked displacement. In children, this anomaly is much more frequent than in grown persons.

Fractures of the clavicle are, according to my experience, seldom cured without more or less deformity, whatever pains may be taken to prevent it. In some of my cases I have found it impossible, despite the greatest care and patience, to effect accurate restoration ; but even when the parts are placed in the closest relations with each other, the slightest movement of the head, neck, trunk, or arm is often sufficient to separate them. This difficulty will, I think, be most likely to occur when the fracture is situated at or towards the acromial extremity of the bone, in which the outer fragment is frequently, if not generally, thrown backwards in such a manner as to render it almost impossible to bring it to its natural position. From the cases that I have seen of this fracture, as treated by other surgeons, and from the numerous specimens of it to be found in our museums, it is certain that a cure without deformity is very uncommon. It is gratifying, however, to know that the deformity, even if considerable, does not generally at all impair the usefulness of the limb. Union will, of course, be materially retarded, but in time nature will succeed in rounding off the ends of the fragments, and in connecting them firmly together, either by an osseous clasp or by a kind of bridge. When union fails to occur, the power of the arm is always weakened. In some cases a false joint is formed, and the ends of the fragments move more or less freely upon each other. Consolidation ordinarily takes place, in the adult, in about five weeks ; in children, in eighteen to twenty days.

Among the more serious effects of fracture of this bone are, violent inflammation of the soft parts, followed by erysipelas, suppuration, and great swelling ; extensive extravasation of blood, with consequent discoloration of the skin ; and paralysis of the arm from concussion, contusion, or compression of the axillary plexus of nerves. These occurrences, especially the latter, are most frequent in compound, comminuted fractures of the clavicle, attended with inordinate displacement of the fragments. A few examples of gangrene of the superior extremity from compression of the subclavian vein have been recorded, and the subclavian artery has occasionally been lacerated. Annoying abscesses sometimes form, and in all compound injuries of this bone, erysipelas is a common occurrence. Gunshot fractures of this bone are often very serious accidents, from the injury inflicted upon the soft parts around both by the bullet and the osseous splinters, which are sometimes scattered about in every direction. Partial paralysis of the superior extremity, with atrophy and permanent contraction of some of the muscles of the arm, forearm, and hand, may be mentioned as an occasional result of these lesions, as in a case recently under my observation in a lad, fifteen years of age, who had the right collar-bone badly broken four months and a half previously by the recoil of a shot-gun.

The *reduction* is generally easily effected by grasping the elbow and carrying the arm upwards, outwards, and backwards. If anything further be required, the fingers may be passed along the broken bone, to mould the ends of the fragments into proper shape. To maintain the parts in this position, the elbow should be permanently secured to the anterior and lateral aspect of the chest, the forearm lying across the front in such a manner as to make the hand grasp the sound shoulder, where it should remain during the whole of the after-treatment. Of the numerous contrivances that have been devised as retentive means in fractures of this bone, I give the most decided preference to that depicted in fig. 460, known as Velpeau's dressing, consisting of a wedge-shaped pad and an ordinary muslin roller, carried around the limb, shoulder, and chest, so as to secure the parts firmly in the position above indicated. The pad should rest in the axilla, with the large end uppermost, and should be well secured to the opposite shoulder by broad tapes. As a preliminary step, the trunk should be incased in a layer of wadding to protect the skin. The different turns of the bandage should be thoroughly wet with a saturated solution of silicate of potassium, applied with a suitable brush, and thus kept permanently in place, the whole forming an immovable dressing, which, unless the weather is very hot, or the skin unusually perspirable, may be worn comfortably without being changed, until the fracture is completely consolidated. If any of the turns of the bandage become loose, they may easily be glued together with the silicate, thus obviating the necessity of renewing the entire dressing.

Fig. 460.

Velpeau's Clavicle Bandage.

The adhesive plaster dressing which I introduced to the notice of the profession in 1852, and which I at one time employed a great deal in the treatment of fractures of the collar-bone, is, when properly applied, not only very efficient, but neat and comfortable, easily renewed, and particularly adapted to children. The strips, which should be from two to three inches in width, may be so arranged as to make a certain degree of pressure, through the medium of a compress, directly upon the seat of the fracture; or, if this be deemed unnecessary, the seat of the fracture may be kept under constant surveillance by letting it remain uncovered. The dressing need not be renewed oftener than once or twice, if, indeed, at all, during the entire treatment. If the skin be covered with hair, the surface should previously be well shaved, to facilitate the removal of the plaster. Any tendency in the shoulder to sink forwards and inwards should be counteracted by means of an axillary pad.

The apparatus of Dr. Fox, for the treatment of fractures of the clavicle, has become classical with the profession of this country, having been in general use for upwards of thirty-five years. At the Pennsylvania Hospital, where it was originally introduced, hardly anything else was, until recently, employed for this purpose. It is composed, as seen in fig. 461, of an axillary pad, of a sling for the forearm and elbow, and a well-stuffed muslin ring to encircle the sound shoulder, and receive the tapes attached to the ends of the sling. An additional support for the hand is suspended from the neck. The apparatus of Dr. Fox has been highly lauded, on the ground that it perfectly fulfils all the indications of treatment. I have not, however, found it at all equal to either of the contrivances above described. Its great defect consists in its allowing too much freedom of motion of the arm, thereby endangering displacement of the ends of the fragments; and a similar remark is applicable to the various modifications of this apparatus by Levis, Hamilton, Bartlett, and other surgeons. The great desideratum is to keep the arm, forearm, and hand immovably fixed, otherwise accurate maintenance of the fractured extremities will be impossible. Hence, in the employment of these contrivances the arm should always be well bandaged to the trunk. An axillary pad I use only when there is a strong tendency in the shoulder to sink downwards and inwards. In all other cases it may very properly be dispensed with, the more especially as its employment, if not carefully watched, may produce undue compression of the axillary vessels and nerves, terminating, as it has occasionally done, in inflammation, ulceration, gangrene, or partial paralysis of the corresponding limb. An instance has been reported in which, from this cause, the brachial artery was obliterated.

The stellate or figure-of-8 bandage was at one time a great favorite with French surgeons in the treatment of this injury, and there is no doubt that many excellent cures

Fig. 461.

Fox's Apparatus for Fracture of the Clavicle.

Fig. 462.
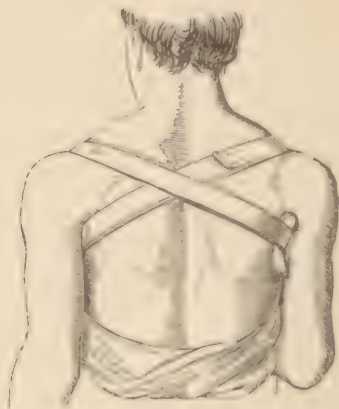
Figure-of-8 Bandage.

were effected with it. It consists, as shown in fig. 462, of a wedge-shaped pad and a long roller, carried alternately around each shoulder, after which the arm and forearm are

Fig. 463.

Boyer's Apparatus.

secured to the side and front of the chest in the usual manner. The bandage of Desault, once so much employed in this country, has become obsolete. Boyer's apparatus for fracture of the clavicle is represented in fig. 463, and is a very neat and efficient contrivance.
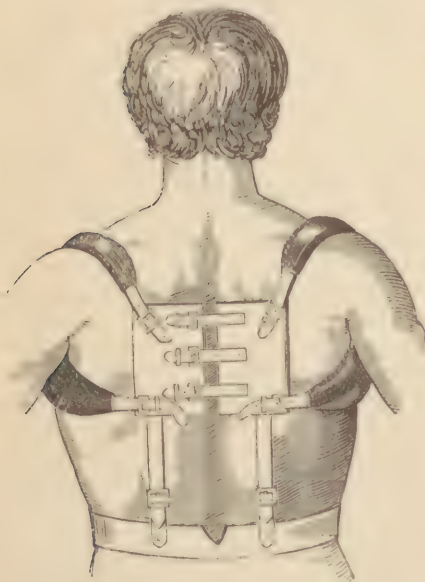
Dr. Moore, of Rochester, prefers to all other contrivances in the treatment of these fractures what he terms the " elbow figure-of-8 bandage," consisting of a piece of cotton cloth, two yards long, and, when folded like a cravat, eight inches in breadth at the middle. The object of this arrangement is to form a sling for the elbow and to carry the arm backward in close contact with the side of the chest, so as to maintain the clavicular portion of the great pectoral muscle in a state of tension. The centre of the bandage resting on the elbow, the posterior tail is carried by a spiral movement across the front of the shoulder of the affected side, and intrusted to an assistant; the other end is then carried across the forearm, raised at an acute angle with the arm, behind the back, over the opposite shoulder, and around the axilla, where the extremities are firmly stitched or pinned together. The forearm is suspended by a broad strip of muslin to the top of the main bandage, the hand being left free. The adjoining cuts, figs. 464 and 465, afford a good view of the arrangement of Moore's dressing.

Dr. Dugas, of Georgia, in fractures of this bone, simply employs a triangular piece of thick, unbleached muslin, to each angle of which is attached a bandage from three to four yards in length by three inches in width. The apparatus, which is described at length in the Southern Medical and Surgical Journal for 1852, is applied in such a manner as to form a sling for the elbow and forearm, at the same time that the arm is firmly secured to the side. No pad is used.

In children the most simple management frequently suffices, in the treatment of this

lesion, especially when the fracture is incomplete, the ends of the fragments remaining partially in apposition. In such a case all that is really necessary is to suspend the forearm and elbow in a sling, and to confine the arm to the chest with a few broad strips of adhesive plaster. In the treatment of fractures of the collar-bone in women special care must be taken in the application of the bandages not to injure the breasts.

Fig. 464.
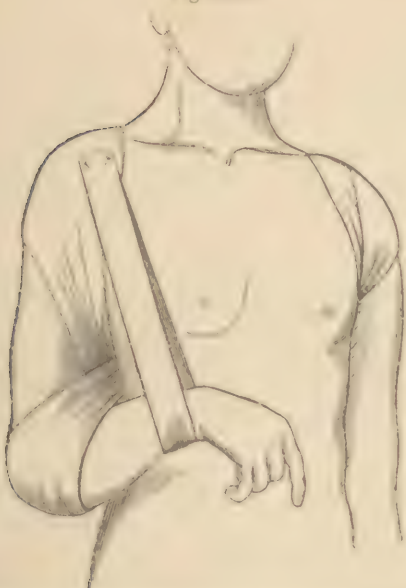
Fig. 465.
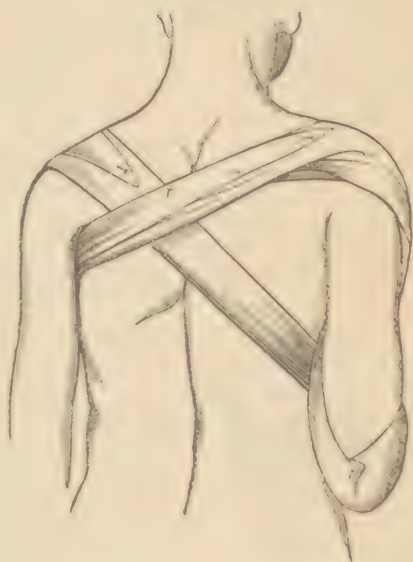
Moore's Apparatus for Fracture of the Clavicle. Front view.

Moore's Apparatus. Back view.

Great stress is very properly laid by surgeons in the treatment of fractures of the collarbone since attention was first prominently directed to the subject by Dr. Edward Hartshorne, of this city, upon the employment of the supine posture, the special efficacy of the plan depending largely upon the pressure made upon the lower angle of the scapula. In order to render the treatment as efficient as possible, the patient's back should rest upon a broad, firm, unyielding mattress, the head should be raised and slightly inclined forwards to relax the sterno-cleido-mastoid muscles, and the forearm and elbow should be supported in a sling across the chest, the palm of the hand grasping the shoulder. To assist in pressing the shoulder backward it has been suggested to keep it covered for the first few weeks with a bag of shot weighing six or eight pounds. The great objection to this mode of management is that it necessitates a long and tedious confinement in bed, which few persons are willing to undergo. Women ought to be more willing than men to submit to it, inasmuch as the avoidance of deformity in them is of much greater importance.

Von Langenbeck, in view of the great difficulty of keeping the ends of the fragments in contact in fractures of this bone, has of late employed the wire suture, and he warmly recommends the general adoption of this measure. Such a procedure, however, is not only difficult, but few cases can arise in which it can be necessary or proper.

When both clavicles are simultaneously fractured, the treatment should be conducted upon the same general principles as when one alone of these bones is broken. Two small axillary pads will generally be required to keep the shoulders properly in place, and the elbows should be raised with more than ordinary care. Confinement of the patient in bed for several weeks will materially conduce to his comfort and rapid recovery. The treatment will be greatly facilitated under such circumstances, by the use of the figure-of-8 bandage, or Boyer's apparatus in keeping the fragments in place.

In comminuted fracture of the clavicle attended with compression of the subclavian vein threatening gangrene of the superior extremity, the only rational procedure is speedy removal of the offending fragment, provided reposition by the ordinary means is unavailing. A compound fracture, in such a case, would be far preferable to the risk of loss of limb and life. Laceration of the subclavian artery, consequent upon comminuted fracture of this bone, must be treated with the ligature, the vessel being tied at both ends.

An ununited fracture of this bone is an unfortunate occurrence, especially when it is caused by great loss of substance, as it is then irremediable. In ordinary cases a seton, cautiously inserted, will answer the purpose; or the ends of the fragments might be connected together with a steel screw, or silver wire.

FRACTURES OF THE SCAPULA.

Fractures of the scapula are extremely uncommon. Of 1902 cases of fractures of different pieces of the skeleton, treated at the Middlesex Hospital, London, only 18, according to Lonsdale, occurred in the shoulder-blade. At the Hotel-Dieu, at Paris, the scapula, in 2358 cases, was broken only in 4. On the contrary, a remarkable disproportion of such cases sometimes occurs in the hands of particular surgeons. Thus, Dr. Dugas has met with four cases of this accident, and Dr. Bullock with not less than six, although neither has witnessed an unusual number of other fractures. The injury may show itself in various forms and directions, and may occupy either of the two processes of the scapula, its neck, its body, or its inferior angle.

α. The *acromion process*, fig. 466, from its exposed situation, is more frequently broken than any other part of the bone, the accident being usually caused by a blow upon the

Fig. 466.

Fracture of the Acromion
Process.

top of the shoulder, or by violence applied directly to the process itself. It may also be produced by force transmitted along the humerus by a fall upon the elbow or the palm of the hand. In a case treated by Mr. Phillips, of London, the accident was the result of muscular contraction. There is reason to believe that what is sometimes regarded as a fracture of this process is merely a separation of its epiphysis, which frequently fails to coalesce with the rest of the bone until late in life, as I have seen in a number of examples. The osseous consolidation is occasionally postponed until after the age of forty. The fracture is generally somewhat oblique, and its signs are so peculiar as to be characteristic. The natural rotundity of the shoulder is destroyed; the outer fragment is drawn down by the weight of the arm, which hangs motionless by the side of the body; the head of the humerus can be felt in the axilla; there is a depression at the situation of the fracture; the distance between the shoulder and the top of the sternum is diminished; and crepitation may be detected on lifting the arm in contact with the displaced fragment. In addition to these symptoms there is acute pain at the seat of the injury; the limb cannot be raised by its own efforts; and the patient inclines his head towards the affected side, and supports the forearm as in fracture of the clavicle.

The only accident with which fracture of the acromion process is liable to be confounded is dislocation of the humerus, from which, however, it may generally be easily distinguished by the sunken appearance of the shoulder, the mobility of the outer fragment, the existence of crepitation, and the ready effacement of deformity by the elevation of the arm, followed by its instantaneous recurrence when the surgeon relinquishes his hold. In dislocation, the acromion process stands out in bold relief, crepitation is absent, and the head of the humerus is firmly fixed in its abnormal position.

The union is usually ligamentous instead of osseous, owing to the difficulty experienced in preserving the contact of the fragments. This occurrence will be more likely to happen when the tip of the acromion is broken off than when the fracture is seated near its root.

In the treatment of this accident the leading indications are to secure the arm and forearm firmly to the antero-lateral part of the chest, and to raise the humerus against the top of the shoulder-joint, so that its head may serve as a splint for the broken process. For this purpose, the same bandage is used as for fracture of the clavicle, but the axillary pad is dispensed with, lest the broken piece should be pushed too far outwards.

β. In fracture of the *neck* of the scapula, fig. 467, the coracoid process and glenoid cavity are detached from the rest of the bone in an oblique direction. The accident is one of such great rarity that many surgeons have doubted the possibility of its occurrence. It can be produced only by great direct violence, although one case—that of Mr. May, of England—is known in which it was caused by muscular contraction in a young lady, in the act of throwing her necklace over her shoulder, the bone having doubtless been exceedingly brittle from some organic defect.

The symptoms are always well marked. The acromion is unusually prominent, the head of the humerus is felt in the axilla, the shoulder has a flattened appearance, the limb is lengthened, the coracoid process is thrown down below the clavicle, between the deltoid and pectoral muscles, severe pain and numbness are experienced in the axilla, and distinct crepitation is perceived on rotating the arm upon the scapula. The accident bears, at first sight, considerable resemblance to a dislocation of the humerus into the axilla, from which, however, it may always be readily distinguished by the facility with which the parts may be restored to their natural situation, by the immediate return of the symptoms when the limb is left to itself, and by the existence of crepitation. From fracture of the neck of the humerus it may be known by the circumstance that, in the latter, the shoulder retains its rotundity, and that the limb, instead of being lengthened, is shortened ; the acromion also is much less prominent.

Fig. 467.

Fracture of the Neck of the Scapula.

In two cases of this accident, observed by Dr. Dugas, the fracture, produced by a blow upon the shoulder from a falling tree, was instantly followed by paralysis of the limb and cessation of pulsation in all its arterial trunks ; a consequence, evidently, of injury done to the axillary nerves and vessels. Treatment having been neglected, no union took place, and the arms never recovered their functions.

This fracture is retained with difficulty, and is liable to be followed by stiffness of the shoulder-joint, atrophy and paralysis of the muscles of the arm, and other disagreeable effects. It is managed in the same manner as fracture of the clavicle, with an axillary pad, the elbow being kept well raised, and the scapula thoroughly steadied until there is complete reunion. If the parts are much contused, leeches, fomentations, and other antiphlogistics may be required. Passive motion should be instituted at the end of four weeks, and afterwards renewed every few days. Consolidation may be expected in two months.

It is not improbable that the edges of the glenoid cavity may occasionally be broken off, either by direct force, or by the sudden and violent propulsion of the head of the humerus. It is remarkable, however, that the existence of such a lesion has never been demonstrated by dissection. Is it not likely that some of the bad forms of luxation of the shoulder-joint, in which the reduction is maintained with great difficulty, and which are so liable to terminate in permanent ankylosis and ruin of the articulation, are cases of this description ? The subject is worthy of greater attention than it has hitherto received.

Fig. 468.

Fracture of the Glenoid Cavity.

Fig. 469.

Fracture of the Coracoid Process.

In the annexed cut, fig. 468, from Fergusson, the fracture extends through the glenoid cavity.

γ. The *coracoid process* is sometimes broken by a severe fall or blow, generally a short distance from its tip, the fracture being usually accompanied by great contusion of the soft parts, and fracture of the acromion, clavicle, or humerus. The accident, which is of very rare occurrence, is characterized by inability to raise and adduct the arm, by preternatural mobility, by depression of the detached fragment by the conjoined action of the small pectoral, two-headed flexor, and coraco-

brachial muscles, and by the detection of crepitation on moving the arm upon the shoulder, the finger being placed between the deltoid and great pectoral muscles. The adjoining sketch, fig. 469, from a preparation in Professor Neill's collection, affords an illustration of a well-marked specimen of fracture of the coracoid process.

The treatment consists in confining the arm and forearm to the anterior part of the chest by means of a bandage and sling, similar to those used in fracture of the clavicle, care being taken to keep the elbow well raised, so as to fix the top of the scapula, and support the broken part. By this proceeding, the pectoral and flexor muscles of the arm are relaxed, and prevented from acting injuriously upon the tip of the coracoid process.

Violent inflammation, occasionally terminating in profuse suppuration, and even in death, is liable to follow this accident, from injury inflicted upon the pectoral muscles and

Fig. 470.

The ordinary Situations of Fracture of the Body of the Scapula.

the axillary vessels, nerves, and glands. The matter, being deep-seated, experiences great difficulty in reaching the surface, and is, therefore, disposed to burrow extensively among the surrounding structures. The proper remedy is an early and free incision at the most dependent portion of the abscess.

δ. The *body* of this bone, fig. 470, rarely suffers from fracture, and then only from great direct violence, causing at the same time serious injury in the soft parts. In one case, recorded by a foreign writer, the accident is said to have been produced by muscular action. The fracture exhibits no regularity in regard to shape, is often multiple, and is rarely attended with displacement.

Fracture of the body of this bone occasionally extends through its spine, so as to divide it into two nearly equal vertical parts, as in a case which I attended with Dr. Rohrer. The patient was a strong laboring man, thirty-seven years of age, who, in a fall from a scaffold, struck his right shoulder violently against the corner of a plank, fracturing the scapula through the spine and body near its centre. Five days had elapsed before I saw him. The parts were then much swollen and ecchymosed, the top of the shoulder was depressed and forced forwards, and there was a marked irregularity between the ends of the fragments, the outer being drawn downwards and forwards, so as to form with the posterior a kind of triangle, thus ⎯⎯⎯⎯ , with distinct crepitation upon the slightest motion. The man, who experienced great pain at the time of the accident, was unable to put his hand to his head, but could easily touch the opposite shoulder.

To steady the shoulder-blade, which is the leading indication in the treatment of this accident, two large, narrow, and moderately thick compresses should be placed along its axillary and vertebral borders, and confined by a broad roller carried round the upper part of the trunk; or, instead of this, they may be secured by means of large adhesive strips. The arm and forearm are fastened to the anterior part of the chest, as in fracture of the clavicle. In the case above described, apposition was easily maintained by a modification of Desault's apparatus.

ε. Fracture of the *inferior angle* of this bone is marked by preternatural mobility, by displacement of the smaller fragment by the action of the great serrated muscle, and by acute pain at the seat of the injury. The diagnosis may readily be established by fixing the top of the scapula and moving the lower angle; if they follow each other, it will be an evidence that there is no fracture, and conversely. The treatment is the same as in fracture of the body of the bone.

FRACTURES OF THE RIBS.

The central ribs, from their exposed and fixed position, are much more liable to be broken than the upper and lower; the former being safely protected by the collar-bone, the scapula, and numerous thick and strong muscles, while the latter, from their great shortness and mobility, can readily glide out of the way of any injury that might otherwise affect their integrity. However this may be, they usually yield at their more prominent points, in an oblique direction, a transverse fracture being here, as elsewhere, an unusual occurrence. A denticulated or serrated appearance of the ends of the fragments is occasionally met with, and now and then, although rarely, they are impacted, or driven

into each other.   The accident is most frequent in elderly subjects, children and young persons seldom suffering.   The causes are twofold, external violence and inordinate muscular action.   The first produces its effect either in a direct or indirect manner; most commonly in the former, as when the ribs are struck by a fall or a blow, or when the body is traversed by the wheel of a carriage.   In the second case, the ribs, being impelled by forces operating upon their extremities, break at or near their middle, as when, for example, the back of the chest is pressed against a wall by a railway car.   When these pieces are acted upon directly, their curvature is diminished, but increased when the violence is applied indirectly.   I recently attended a lady, seventy-four years old, who had the eleventh rib of the left side fractured by her granddaughter, a stout girl of fourteen, by throwing her arms around the body, in a friendly embrace, on going to bed.   In 1837 a number of persons met with severe injuries of this kind, by being severely squeezed in a crowd in the Champs de Mars, at Paris.   A rib has occasionally been broken by mere muscular contraction in the act of coughing, sneezing, or slipping, as in a case reported by Dr. Groninger; but such an occurrence is unusual, and generally implies an abnormal condition of the osseous tissue.

Fractures of the ribs are said to be common among insane persons, but whether they occur spontaneously or as the result of accidental causes is not determined.   In many of the reported cases they did not seem to have been productive of pain or to have been accompanied by the usual phenomena, not even by any evidence of contusion or discoloration of the skin.

The number of ribs broken at any one time is variable.   The largest number I have ever met with was eight; sometimes, however, it is still greater.   In a specimen in my collection, from the body of a woman, upwards of seventy years of age, who threw herself out of a second-story window, there are not less than fifty-nine fractures, twenty-seven on the right side and thirty-two on the left.

The fracture may occur simultaneously upon both sides, as in the case just mentioned; and it may be either simple, or complicated with other injury, as rupture of the intercostal artery, wound of the soft parts, and laceration of the pleura and lung.

A fracture of the more superficial ribs is often easily detected simply by placing the hand upon the part where the violence is supposed to have been inflicted, and requesting the patient to cough.   The bones being thus obliged to undergo a sudden motion, the lesion, if any exist, will almost be sure to manifest itself by the occurrence of crepitation and preternatural mobility.   If, however, the fracture is placed under cover of a large quantity of muscular and fatty matter, as in certain situations in robust and corpulent subjects, it may be very difficult, if not impossible, to discover it.   In such an event, the examination should be repeated again and again, until the diagnosis is satisfactorily determined.   The difficulty will be increased if only one rib is broken, or if the broken bone retains its normal position; on the other hand, the diagnosis may be established at a glance if the injury is extensive, and attended with marked displacement, as when it has been inflicted by a fall, or by the kick of a horse.   Finally, the patient, as he takes a deep inspiration, is occasionally sensible of a peculiar cracking noise at the site of the fracture.

The pain attending the fracture of a rib is generally very acute, and is always most severe at the seat of the injury; it is aggravated by the respiratory movements, and is commonly so excessive as to compel the patient to breathe entirely with the diaphragm. Every attempt at a full inspiration, coughing, or sneezing, is followed by exquisite suffering.   In very violent cases, the pain resembles that of pleurisy, and is accompanied with intense thoracic oppression.   If the lung has been wounded by a spicule of bone, or the projecting end of the broken rib, there will probably be spitting of blood, if not hemoptysis, and, perhaps, also emphysema.   In the latter event, the air may fill the cavity of the chest, causing a hollow, drum-like sound on percussion, and total extinction of the respiratory murmur, attended with great increase of dyspnoea.   Sometimes, as in injury of the costal and pulmonary pleura, the air escapes into the subcutaneous connective tissue forming a diffused tumor, soft and crackling, and at once indicative of the nature of the case. More or less copious hemorrhage will be present when there is laceration of an intercostal artery, the blood occasionally passing into the chest, but more generally escaping externally.

The ribs being firmly connected to the costal cartilages in front, and to the vertebræ behind, it is impossible for them to undergo any shortening when they are fractured, or for the ends of the fragments to overlap each other, at least to any extent, as in fracture of the long bones.   Derangement, however, may take place in almost any other direction, although the angular displacement is by far the most common, and this may be either

outwards, as in fig. 471, or inwards, as in fig. 472, according to the manner in which the injury was inflicted, the latter being usually produced by direct violence, the former by indirect. It is seldom, however, that more than one end of the bone is displaced in this direction at the same time. The Mütter cabinet contains several specimens in which one of the fragments projects above the level of the others.

Fig. 471.
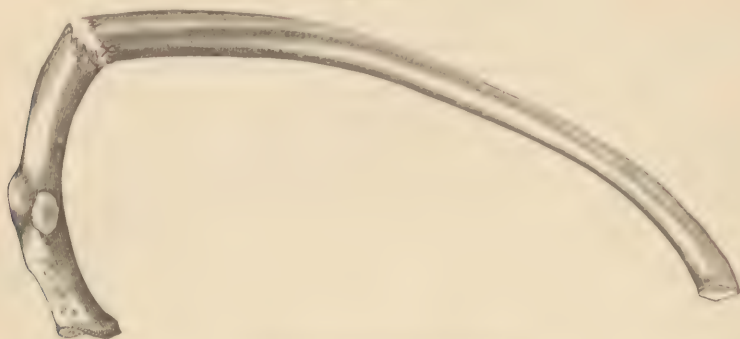
Angular Displacement Outwards.

Fractures of the ribs are not always devoid of danger, even when they are perfectly simple, or apparently free from complications. Their number may be so great as to occasion severe shock, or such an amount of local and constitutional disturbance as to cause alarming illness and even death. The danger is generally greater, other things

Fig. 472.
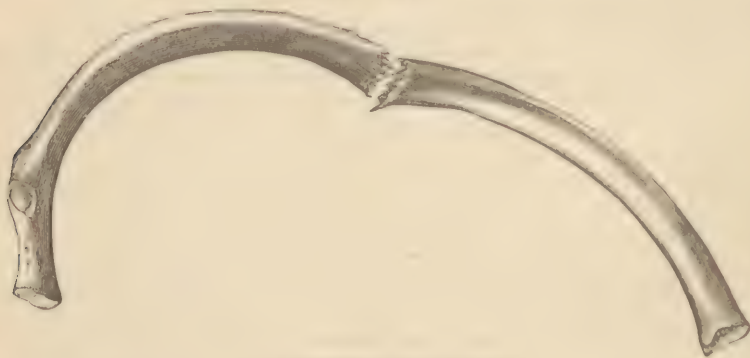
Angular Displacement Inwards.

being equal, in fracture of the upper ribs than in fracture of the middle and lower, because a greater degree of violence is generally required to produce it. A fracture complicated with injury of the lung and pleura must be looked upon as a serious occurrence, as it is sure to be followed by more or less inflammation, if not by hemorrhage and pneumothorax. An escape of air beneath the skin is a matter of no consequence, except as indicating serious lesion within the chest. Hemorrhage from a wound of an intercostal artery is usually rather troublesome than dangerous.

A case, under my observation in 1854, strikingly illustrates the danger of fracture involving a number of these bones without any very serious complication. A tall, slender woman, fifty-four years of age fell, while the railway cars were in the act of running off the track, against the top of one of the seats, breaking eight of the ribs on the left side. The second, third, fourth, and fifth bones were fractured in front, about two inches and a half from their cartilages, while the eighth, ninth, tenth, and eleventh had given way behind, within a short distance of the spine. There was no displacement of any of the fragments, excepting the posterior one of the tenth rib, which projected slightly inwards towards the chest, and pierced the pleura. Excessive pain, dyspnœa, crepitation, and preternatural mobility marked the accident. The cough was violent, and recumbency impossible. The ordinary treatment was pursued, but without any material benefit, and the woman died exhausted at the end of the fourth day. The left side of the chest con-

tained about three ounces of coagulated blood, evidently furnished by the wounded pleura, but there was no sign of inflammation, except at the seat of the upper fracture, where the serous membrane was a little roughened by lymph and slightly ecchymosed. The lung was free from disease. All the other organs were sound.

Fracture of the ribs, without complication or displacement, is easily managed with the plaster or glass dressing, the surface being protected with a layer of wadding, or an ordinary flannel shirt. The bandage should be from two and a half to three inches in width, and drawn so tightly as to compel the patient to breathe chiefly with the diaphragm. A thin, flat compress, as a small, old towel, properly folded, to give greater support to the broken bone, may sometimes be advantageously used. In children I know of no better dressing for a fractured rib than one made of adhesive strips.

Similar dressings will answer in outward displacement of the fragments, only that a somewhat thicker compress may be necessary; if, on the contrary, the bone is driven inwards towards the chest, it is obvious that counterpressure applied to the extremities of the broken rib can be of no avail. When there is a wound, it might be easy enough to insinuate a small lever, to raise the bone, if not to its proper level, at least out of harm's way. My conviction, however, is that there should be no such interference, even when the depression is considerable, and the case most urgent, unless a fair trial has been made of other means, as the bandage and ordinary antiphlogistics, especially the lancet, leeches, and the free use of anodynes. If relief do not follow, and it is perfectly clear that the suffering depends upon the vicious projection of the ends of the fragments, no surgeon would hesitate to expose the parts, and use his best endeavors to rectify the displacement. Cases requiring such heroic measures must, however, be exceedingly rare, and hardly deserve formal mention in a work of this kind.

Wounds, contusions, and hemorrhage, consequent upon these accidents, must be treated upon general principles. When the blood proceeds from an intercostal artery, it may be necessary to enlarge the opening in the chest, or even to excise a portion of an adjacent rib, as in a case during our late war in the hands of Dr. Cuyler, of the army. If air collect within the chest in sufficient quantity to cause excessive respiratory embarrassment, it should be evacuated with the aspirator or a delicate trocar, introduced through a valvelike opening in the skin. Pain and cough are relieved in the usual manner. If the local distress is urgent, leeches may be used, followed by the application of a large opiate plaster.

Fig. 473.

Fractured Ribs united by Osseous Matter.

The patient observes the semierect posture, and remains within doors until he is able to exercise with impunity. If the bandage becomes insupportable, it must not be laid aside, but simply slackened.

Cases occasionally occur in which the rational symptoms of fracture of the ribs exist, but the characteristic signs are absent. The rule of practice, under such circumstances, is to treat the patient precisely as if the bones were actually broken.

The annexed drawing, fig. 473, from a specimen in my collection, affords an illustration of the manner in which the ribs, after fracture, are sometimes bound together by bony matter.

FRACTURES OF THE COSTAL CARTILAGES.

Fracture of the costal cartilages is so uncommon that a long time elapsed before surgeons were willing to believe in the possibility of such an occurrence. That it does take place, however, is a fact fully established by modern observation; and, what is remarkable, experience has shown that it is not always necessary for these bodies to be ossified before they can be broken, although this is usually the case. The accident, which is observed chiefly in elderly persons, is invariably produced by external violence, either directly or indirectly applied. The fracture is usually single, and the pieces which are most liable to suffer are the fifth, sixth, and seventh, owing probably to their great length and to their exposed situation. The direction of the fracture is commonly somewhat oblique, and the ends of the fragments often overlap each other, the posterior passing in

front or behind the anterior, which, from its connection with the sternum, serves as the fixed point.

The symptoms are similar to those of fractured ribs. The accident, whether simple or complicated, is, in general, comparatively free from danger. The broken ends are united by a clasp or ferule of bone, in which the cartilaginous tissue remains measurably unchanged. The reduction and maintenance of the fracture are often very difficult, but by a careful observance of the rules laid down under the head of fracture of the ribs, a cure may usually be effected in six or eight weeks. Malgaigne advises the use of a broad truss for keeping the fragments together, the pad making direct but gentle pressure upon their extremities. In obstinate cases they might be united with silver wire.

FRACTURES OF THE STERNUM.

This bone may give way in almost any portion of its extent, but more commonly near its middle, the direction of the fracture being generally somewhat oblique. Instances of longitudinal fracture of the sternum have been observed by Meyer, Malgaigne, and others, as the result of severe injury. Diastasis of this bone is exceedingly infrequent; and, so far as I know, there are only a very few well authenticated examples of fracture of the ensiform cartilage upon record. In one of these the patient, a man, twenty-eight years of age, met with the accident in a fall in which he struck the lower extremity of the sternum against the top of a candlestick, bending the cartilage at a right angle with this bone towards the spine, and causing by its pressure upon the stomach frequent and violent attacks of vomiting for a long time afterwards.

Blows, kicks, and falls are the ordinary causes of fracture of the sternum. Examples in which it was occasioned by violent muscular contraction during labor, have been recorded by different observers. In 1858 I attended, along with Dr. Rohrer, a case, in a large, heavy, muscular man, forty-seven years of age, who had received a transverse fracture of the upper part of this bone, from inordinate contraction of the sterno-cleido-mastoid muscles, in jumping, in a state of intoxication, off a shed eleven feet high. The heels, striking the ground obliquely, threw the body violently backwards, the head and neck coming in contact with the edge of a board. The fracture was, doubtless, occasioned by the effort which the man made to regain his equilibrium.

The ends of the fragments either preserve their natural relations, or, if displacement occur, it will be in the direction of the thoracic cavity, when the broken bones may lacerate some of the contained viscera, cause effusion of blood into the anterior mediastinum, and, perhaps, induce emphysema by wounding the lungs.

When the fracture is attended with displacement, it may usually be detected at a glance, or by merely passing the finger over the line of injury. Grating, sometimes audible at a considerable distance, and increased at every respiratory effort, is generally present. The pain is excruciating; recumbency is, for a time at least, impracticable; and there is great dyspnœa, along with cough, spitting of blood, and other evidence of internal injury.

In the case above referred to, there was, even several days after the accident, a marked depression at the site of the fracture, with considerable irregularity of the ends of the fragments, which was much increased when the patient sat up in bed. During recumbency, when he coughed hard, the hand, placed over the seat of the injury, could distinctly feel the fragments ride over each other, the upper evidently moving more freely than the lower. It seemed as if their edges had been bevelled off obliquely, that of the lower piece from above downwards and from before backwards, that of the upper in the opposite direction. Two or three times, as the man coughed, a distinct grating noise was heard. Percussion upon the spine, immediately opposite the fracture, had also the effect of displacing the ends of the fragments, and a similar result followed when firm pressure was made upon the anterior surface of the fragments. When the case was first seen, the upper piece was thrust backwards towards the thoracic cavity, fully one inch behind the level of the other; but it was easily restored to its natural situation by bending the chest backwards over a thick pillow. The pain at the seat of fracture was comparatively slight; but very distressing in the back of the neck and head. There was neither cough nor emphysema, and the fever that followed was slight.

The prognosis varies. When the thoracic organs have sustained much violence, the patient may die from shock, hemorrhage, or emphysema; or, surviving the immediate effects of the accident, he may perish from the consequences of inflammation of the

lungs, abscess of the mediastinum, or disease of the bone itself. In the Mütter Museum there is a skeleton in which a fracture of the sternum, near its middle, had undergone perfect repair, although not without marked deformity from the want of accurate apposition. Evidence of fracture exists in several other bones, and there must also have been a remarkable predisposition to the development of exostoses, the number of which is very considerable.

The *treatment* is, in great measure, restricted to the application of compresses and an immovable bandage, to afford support to the chest and quietude to the intercostal muscles. In the event of serious internal complication, local and general bleeding, active purgatives, antimonials, and anodynes may be required, along, perhaps, with medicated fomentations. If the fracture be simple, no attempt should be made to rectify the depression of the offending fragment, unless it is causing compression of the heart or lung. In such a case, and also when there are loose pieces of bone projecting into the chest, restoration should promptly be effected at all hazard. To accomplish this, the patient may lie across a table, over a double inclined plane, in order to extend the spine, and afford the muscles attached to the extremities of the sternum an opportunity of drawing the ends of the broken bone asunder. While this is being done, pressure should be made upon the parts in a direction opposite to that of the displacement, at the same time that the lungs are, if possible, thoroughly distended with air. Or, this failing, the bone, the body being still in this position, may, perhaps, be raised with a small, delicate elevator, used subcutaneously, supposing that a wound does not already exist. If this also prove unsuccessful, the urgency of the case will fully justify the application of the trephine, or the removal of a sufficiency of bone with a Hey's saw. A similar procedure may be necessary when an abscess forms in the anterior mediastinum, or when a portion of the sternum is ulcerated or necrosed, although in the former event it may not always be possible to reach the fluid.

In fracture of the ensiform cartilage with outward protrusion of the fragment, the chief reliance must be upon systematic and long-continued compression with a well-adjusted pad, confined with a suitable bandage. When the point of the bone is driven backwards towards the spine, forming a right angle with the lower extremity of the sternum, and causing more or less suffering by its pressure upon the stomach, as nausea and vomiting, the only resource is excision, an operation requiring some care and skill for its successful execution, but in every respect proper.

FRACTURES OF THE VERTEBRÆ.

The vertebræ are so compactly constructed, so strongly articulated, and so thickly covered by muscles, as to render their fracture a matter of great difficulty. The most common causes are violent blows or falls, giving rise at the same time to severe injury of the soft parts. Occasionally the lesion is produced by contre-coup, as when a person falls from a great height and alights upon his feet, the force being transmitted along the extremities and the pelvis to the spinal column, where, concentrating upon a particular bone, it breaks its substance or severs its ligamentous connections. Any part of such a bone may give way, its body, plates, and processes being all liable to yield under the influence of the causes here mentioned. The symptoms and effects of this lesion must be considered with reference to the different divisions of the vertebral column, as the cervical, dorsal, and lumbar, each possessing certain peculiarities growing out of its relations with the spinal cord and the nerves which are detached from it.

In fracture of the *cervical vertebræ*, the symptoms vary according to the situation of the affected bone. Thus, if the lesion is above the fourth piece, or the principal origin of the phrenic nerve, and the spinal cord is at all compressed, the diaphragm will be paralyzed, the respiration will be more or less embarrassed, and death will follow, either immediately, or within a short time after the accident. If, on the other hand, the fracture is seated below this point, there will be paralysis, to a greater or less extent, of all the extremities, embarrassment of breathing, relaxation of the anal sphincters, incontinence of urine, and tympanitic distension of the abdomen. When the fracture is oblique, one arm is sometimes more disabled than the other. Recovery may ensue if the injury of the soft parts is not very severe, but in most cases death occurs in from three to five days.

Fracture of the *odontoid process* is very uncommon, and generally proves promptly fatal from injury to the spinal cord. Now and then, however, a remarkable exception is found. Thus, in a case related by Dr. Willard Parker, the patient survived the accident five months, when he suddenly expired from displacement of the process, during some inad-

vertent movement of the head, a result favored by the destruction of the occipito-axoid ligament. The dissection showed that the odontoid process had been completely broken off, and that its lower extremity had been turned backwards towards the spinal cord, as exhibited in fig. 474. The patient, a man, forty years of age, had been thrown violently from his carriage, alighting, about fifteen feet off, upon his head and face. After recovering from the immediate effects of the accident, he was able to resume his business as a milkman, which he followed, diligently and uninterruptedly, every day for four months. He complained, however, constantly of pain in the occipito-cervical region, and was always obliged to support his head, which he was incapable of rotating. The only visible deformity was a protuberance of the neck, just below the base of the occiput, to the left of the median line, with a corresponding indentation.

Fig. 474.

Fracture of the Odontoid Process of the Axis: *a*, Broken Surface; *b*, Odontoid Process.

Hyrtl has reported a case of fracture of the odontoid process which occurred very unexpectedly in a woman while sitting up in bed to take her meal. Death was instantaneous. The bone was found to be diseased. In a case related by Professor Flint, the bone, inflamed and softened, gave way in consequence of a blow inflicted upon the neck a few months before.

In fracture of the *dorsal vertebræ*, the upper extremities are free from paralysis, unless the injury is seated very high up, when they may participate in this affection with the subdiaphragmatic portions of the body. The bowels, in either case, will be torpid and distended with gas, and the bladder unable to expel its contents. Life is seldom prolonged beyond a fortnight, although in some rare cases it lasts for several months. In this event, the bowels and bladder may partially regain their original tone, but the urine soon becomes loaded with phosphates, and the lining membrane of the bladder suffers from subacute inflammation, adding thus greatly to the patient's discomfort.

When the *lumbar vertebræ* are broken, the lower extremities are generally deprived both of volition and sensibility, the feces pass off involuntarily, and the bladder is unable to relieve itself. Life usually lasts longer than in fracture of the dorsal vertebræ, the paralysis not extending so high up, and, consequently, not involving so many important organs. In the majority of cases, the patient dies in five or six weeks; but he may survive a much longer time, the bladder suffering as in fracture of the other divisions of the spine.

Priapism is an occasional symptom of these accidents; it is evidently dependent upon lesion of the spinal cord, and is most liable to occur when the injury is situated high up in the neck. It is generally associated with paralysis, and is nearly always an early phenomenon, manifesting itself within the first forty-eight hours, and often continuing, more or less obstinately, up to the moment of dissolution. It is sometimes present even when there is complete deprivation of sensibility and consciousness.

The sexual powers are sometimes remarkably preserved after these injuries, as in an interesting case recorded by the late Professor Childs, of New York. The man, who lived for fifty-three years in a perfectly paraplegic condition, consequent upon a fracture of the twelfth dorsal vertebra, was married at the age of thirty-six, and became the father of six children. The spinal cord was completely atrophied below the seat of the injury. The capacity for coition was unimpaired, but there never was any venereal orgasm. Sensation existed only in front of the abdomen, of the scrotum, and of the thighs. The urine was expelled, after the first four weeks, by a painful effort of the will, aided by a loop of rope tightly twisted with a stick over the hypogastric region.

The symptoms here enumerated may follow fracture of any portion of a vertebra, except, perhaps, that of the spinous process, when the suffering is generally comparatively slight, unless the lesion is complicated with serious mischief of the spinal cord.

The concussion of the spinal marrow, which so frequently attends these accidents, especially when induced by severe falls, or blows, may be so violent as to cause death almost instantaneously. When the case is less urgent, the patient may live, but will be likely to suffer, temporarily, from loss of power, partial or complete, of the sphincter muscles of the bladder and anus, and, permanently, from paralysis of the lower extremities, if not also of the upper.

Fracture of the *spinous* processes of the vertebræ occasionally occurs independently of the bodies of these pieces, as seen in fig. 475, the usual exciting cause being a blow, fall,

or kick. Preternatural mobility and lateral displacement, with more or less contusion and discoloration of the soft parts, are the most reliable phenomena.

Fracture of the *arches* of these bones, of which the accompanying cut, fig. 476, affords a good illustration, is often comminuted, and attended with depression of the fragments, some of which may be driven into the substance of the spinal cord, crushing and pulpifying it. It is generally produced by violence directly applied, and is frequently quite as dangerous as a fracture of the bodies of the vertebræ.

Fig. 475.   Fig. 476.
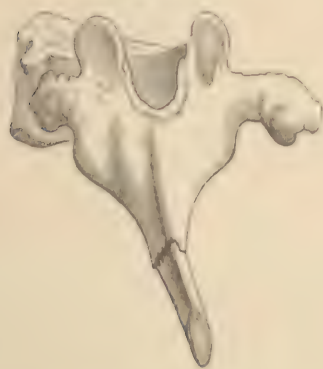
Fracture of the Spinous Process.   Fracture of the Vertebral Arches.

The *transverse* processes of the vertebræ can only be broken by excessive force, as the passage of a ball, or a severe blow, or a fall from a considerable height. Hence the result of such accidents is commonly very unfavorable.

The *diagnosis* of fracture of the spine is usually a matter of inference rather than of positive conviction. Its most important elements are the mode of production of the injury, and the paralysis of the extremities, but it should be recollected that this symptom may depend entirely upon lesion of the spinal cord, unconnected with fracture of the vertebræ; and cases have been observed by Cooper, Dupuytren, South, and others, in which the effects of violent strains of the spinal ligaments and muscles closely simulated fracture of these bones. Owing to the small size of these bones, and the manner in which they are covered in by the muscles of the back, it is generally impossible to detect either crepitation, deformity, or preternatural mobility. All these phenomena may, however, be present in fracture of the spinous processes.

Dissection, after an injury of this kind, usually reveals more or less displacement of the broken bone, which is sometimes quite comminuted, laceration of the connecting ligaments, and injury of the spinal cord, with more or less extravasation of blood in the spinal canal and the surrounding parts. The cord is compressed, bruised, pulpified, perhaps nearly completely severed, pieces of bone sometimes being imbedded in its substance, as shown in fig. 477.

Fig. 477.

The *prognosis* of these accidents may be inferred from what has been said respecting their symptoms and effects. If the patient escape immediate destruction, he will almost certainly succumb under his suffering at no very remote period; or, if life be spared, be doomed to carry on a miserable, bedridden existence, palsied and otherwise crippled in the exercise of some of his more important functions. A remarkable case of fracture of the fifth dorsal vertebra, with displacement of the bodies of the third and fourth of these bones, in which, notwithstanding the complete division of the spinal cord, life was prolonged for two months, has been recorded by Dr. Parkman, of Boston.

Fracture of the Vertebræ.

In the *treatment* of fractured vertebræ, very little is to be done in the way of restoring displaced fragments, all such attempts being not only uncertain, but, even if successful, likely to aggravate the danger by the additional mischief that is inflicted upon the spinal cord. The same remark is applicable to the operation of cutting down upon the injured part, and

removing the offending portion of bone with the trephine or saw, as originally suggested by Paul of Ægineta, and first practised, in 1814, by Mr. Henry Cline, of London. Of 38 cases, tabulated by Dr. John Ashhurst, in which this procedure has been employed, including those of Barton, Rogers, Potter, Blackman, Hutchinson, and Stephen Smith, 29 died, 3 were relieved, 2 were not benefited, and the result is unknown in 4. In the cases reported as relieved, the improvement was only partial, a circumstance that might have been expected when it is recollected how seriously the spinal cord is generally injured by the depressed fragments. The operation, although difficult, on account of the great depth at which the broken bone is situated, may be executed with but little loss of blood; and I must confess that, notwithstanding the want of success which has hitherto attended it, I should feel strongly tempted to resort to it, if the symptoms were such as to render it certain that the lesion was accompanied by depression.

Whether an operation is performed or not, it is clearly the duty of the surgeon to adopt prompt measures for the prevention of inflammation. With this view, blood is freely taken from the arm, and also by leeches from the seat of the injury; the bowels are relieved by purgatives or stimulating enemas, and pain is alleviated by full doses of anodynes, combined, if there be much fever, with depressants. The bladder is carefully watched, and the urine, if retained, is drawn off regularly twice or thrice a day, instead of allowing the catheter to remain permanently in the bladder. The patient is kept on his back, upon an air- or water-bed, his head resting upon a low pillow, and his position being as seldom changed as possible. Great care is taken not to turn him upon his face, as he might be almost instantly asphyxiated while in this situation, from the imperfect descent of the diaphragm, caused by the pressure of the abdominal viscera, on account of the paralyzed condition of the abdominal muscles, and their consequent inability to offer any resistance to the weight of the body. After the lapse of a few weeks, the back and limbs should be frequently rubbed with stimulating liniments, and a large issue established in the vicinity of the injury with the actual cautery. Along with these means, trial may be made of small doses of strychnia, in union with iron, quinine, and mercury, especially if there is evidence of the existence of spinal meningitis, or of extravasated blood. All treatment of this kind will, of course, be useless when the spinal cord has been crushed.

When the lesion is confined to the spinous processes, the fragments must be moulded into shape, and retained by two long, thick compresses, stretched along the side of the spine, and secured with a circular bandage, fastened by a scapulary. If the broken pieces, however, are much shattered, so as to preclude the possibility of reunion, they should be removed.

FRACTURES OF THE PELVIC BONES.

α. The *innominate bone* may give way in various parts of its extent, but the one which is most apt to suffer is the upper crest, owing probably to its exposed situation.

The *acetabulum* is sometimes broken by a severe blow upon the hip, or by a counter-stroke, as when a person falls upon his knee or foot, thereby driving the head of the femur into the pelvis. The most common form of the accident is that in which the lip or border of this cavity is chipped off, either as a single piece of variable size and shape, or where it is broken into several fragments. In the adjoining cut, fig. 478, from a preparation in the possession of Professor Neill, the fracture runs in a semicircular direction through the acetabulum. Occasionally the floor of the acetabulum is driven by the head of the thigh-bone into the pelvic cavity, so as to inflict more or less injury upon its contents. In young sub-

Fig. 478.
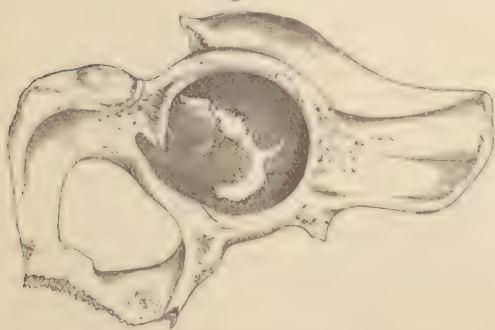
Fracture of the Acetabulum.

jects, the innominate bone has been found separated at the acetabulum into its three primitive pieces. In a case of this kind, dissected by Moore, the head of the femur had completely penetrated the pelvic cavity, the limb, placed in a state of slight flexion and adduction, being shortened two inches.

Whatever may be the site, form, or extent of these fractures, they can happen only through the agency of direct mechanical violence, which, at the same time, generally seriously compromises the soft structures, both outside and inside the pelvis. The most frightful accidents of this kind that have fallen under my observation have been the result of railway injury, caused by the body being jammed in between a car and a wall, literally crushing the bone, and fatally implicating the bladder and other organs.

The symptoms will necessarily vary according to the seat and extent of the fracture. When the bone has given way at the cotyloid cavity, the nature of the case may usually be recognized by the circumstance that the head of the femur is drawn upwards, and the great trochanter somewhat forwards, so that the limb is diminished in length, and the foot inverted. When the head of the thigh-bone is impacted in its new position, the limb may be firmly fixed, as in dislocation, but, in general, it will be found to be more or less movable, and to afford distinct crepitation when an attempt is made to rotate it. Fracture of the brim of the acetabulum is generally associated with dislocation of the femur, and hence, although the reduction of both injuries may be sufficiently easy, yet the displacement is sure to recur the moment the efforts required to effect this object cease.

The diagnosis of these accidents is very uncertain, and, in many cases, their true nature is only discovered on dissection. The most reliable signs are, shortening from six lines to an inch and a half, inversion of the foot, unnatural elevation of the great trochanter, excessive pain on pressure over the joint, crepitation, generally more decided than in fracture of the neck of the femur, and prompt effacement of the deformity under extension and counterextension, followed by an immediate return of it when these efforts are discontinued.

The prognosis of fracture of the acetabulum is variable. In many cases, the injury inflicted upon the bones and soft parts is so great as to cause death either from shock or from inflammation. When the patient recovers, he is usually maimed for life, as the case is either misunderstood, or, if understood, unsuccessfully treated, often as a necessary consequence of the peculiar character of the injury, and, therefore, without any just blame as it respects the skill of the professional attendant. In the female, a fracture of the floor of the acetabulum, accompanied with great displacement, might seriously interfere with parturition, and in both sexes the pressure of the bone upon the pelvic nerves might become a cause of severe and protracted neuralgia.

In regard to the treatment of these injuries it is difficult to lay down any definite plan. When the floor of the cavity is broken, reposition is, of course, impracticable, and the less, therefore, the case is interfered with the better. When the fracture involves the rim of the bone, and coexists with displacement of the femur, an attempt should be made to maintain the parts in their proper relations by keeping the limb in a straight line with a long side splint and a weight appended to the foot, while the joint is carefully supported with a broad compress confined by a suitable band passed around the pelvis.

In fracture of the *pubic* and *ischiatic* bones, the corresponding limb is either somewhat shortened, or it retains its natural length; the fragments are pushed either directly downwards, forwards towards the femur, or backwards towards the acetabulum; the patient is unable to sit, stand, or walk; and on placing one hand upon the ilium, and the other upon the pubes, crepitation may usually be perceived. A well-characterized fracture of the pubic and ischiatic bones is delineated in fig. 479, from a preparation in the collection of Professor Neill. A very interesting case, of a similar nature, attended with fatal injury of the bladder, occurred a few years ago under the observation of Dr. John W. Lodge, and is fully described in the American Journal of the Medical Sciences for October,

Fig. 479.

Fracture of the Pubic and Ischiatic Bones.

1865. A case of fracture of the body of the pubic bone by muscular contraction, in a very stout, hard-working woman, forty-three years of age, in the act of lifting a heavy stone, has been reported by Letenneur, of Nantes.

The pubic bones are sometimes severed at their symphysis. Of four cases collected by Malgaigne, the accident, in three, was occasioned by muscular contraction during the forcible abduction of the thighs, and of these two perished. The same author has analyzed seventeen cases in which the separation occurred during parturition, with a loss of ten. Maret met with an instance of fracture of the pelvis in which he was obliged to excise nearly
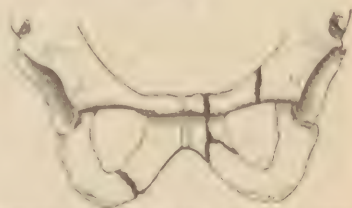
the whole of the body of the pubic bone by an incision through the labium. The fragment had been pushed forward and inward, and interfered with the introduction of the catheter, rendered necessary on account of retention of urine. The patient, a girl eighteen years of age, not only made a good recovery, but afterwards gave birth to two children in easy and natural labors.

Fracture of these bones is generally produced by severe injury, and is, therefore, nearly always complicated with serious lesion of the soft parts. Cappelletti met with an instance in which their branches were broken by violent muscular contraction, as the patient, a man, fifty-four years old, was jumping out of his carriage, while the horses were running away. A case of fracture of the anterior superior spinous process of the ilium by muscular contraction has been reported by Dr. Joy and Dr. McWhinnie, of Canada.

Fracture of the crest of the *ilium* is characterized by more or less displacement, preternatural mobility, and crepitation; the pain is severe, and progression impracticable. The nature of the accident is sometimes rendered apparent by the existing deformity and by slight manipulation.

Besides the above symptoms, denotive of fracture of different parts of the innominate bone, there are always more or less contusion of the external soft parts, and not unfrequently, also, serious injury of the pelvic viscera, followed by loss of motion of the inferior extremities, retention of urine, and other distressing affections. The prognosis should, therefore, be very guarded, as such accidents are generally fraught with danger, death often occurring in a few days from inflammation or extravasation of urine, or, at a later period, from abscess, phlebitis, and other mischief. Of 65 cases of fracture of the pelvic bones, analyzed by Dr. J. W. Lyon, 41 recovered, and 24 died, one-half of the latter having labored under rupture of the bladder.

Owing to their peculiar character, it is usually found very difficult to reduce these fractures, or to prevent relapse after this has been done. To effect restoration, our main reliance must be upon pressure, while the maintenance is best accomplished by well-arranged compresses, secured by a belt or an immovable bandage. Even when no displacement exists, great comfort will be experienced from such support. In any event, the utmost quietude must be enjoined; the patient must lie upon his back, his shoulders being elevated, and the thighs flexed, to relax the muscles about the pelvis; inflammatory action is promptly dealt with, and the bowels are moved as seldom as possible. The bladder is carefully watched, retention of urine being relieved with the catheter. An air-bed sometimes affords great comfort in such a condition.

β. The *sacrum* may be broken by falls, blows, gunshot violence, and similar injury, usually in a transverse or oblique direction; a comminuted condition is sometimes observed, and Richerand met with a case in which the fracture was vertical. The lesion is generally discoverable, especially when attended with displacement, by mere manual examination, as the patient lies upon his abdomen. It is accompanied with severe pain at the affected part, and great difficulty in walking, associated, when there is involvement of the sacral nerves, with paralysis of the lower extremities, retention of urine, and involuntary discharge of the feces. The danger attending this accident is always considerable, on account of the mischief done to the soft parts; hence, even if the patient survive the immediate shock of the injury, he may perish afterwards from the effects of inflammation of the pelvic viscera.

When the fragments are pushed inwards, reposition may be attempted by the insertion into the rectum of a stout bougie, a lithotomy scoop, or a vesical sound, care being taken not to do any injury to the mucous membrane; or, if the displacement is very slight, the bone may be left in its new situation, as it can then not do any harm. Backward displacement may easily be remedied by pressure with the finger, relapse being prevented by a compress and a T bandage. Recovery is promoted by rigid recumbency, antiphlogistics, and the use of a water bed.

A remarkable case of compound fracture of the sacrum, caused by a railway accident, attended by discharge of urine through the wound, and ultimately followed by recovery, has been reported by Dr. H. D. Burlingham, of Illinois, in the American Journal of the Medical Sciences for April, 1868. The bladder was supposed to have been torn at its neck. The urine, after the first few days, was allowed to flow off constantly through the catheter.

γ. The *coccyx* is sometimes broken by a fall, by a kick upon the buttock, or by the passage of the child's head in labor. The accident is most common in elderly subjects, in whom the joints of this bone have been destroyed by a deposit of osseous matter. The characteristic signs are, preternatural mobility, acute pain, and crepitation on introducing

the finger into the bowel.   Paralysis of the bladder and rectum is a frequent, if not general, phenomenon.   During labor, the occurrence of the injury is sometimes rendered evident by a sense of yielding and a peculiar noise perceived by the attendant as he is engaged in supporting the perineum.   If displacement exist, it is remedied by pressure upon the surface and counterpressure with the finger in the rectum.   It is very important, especially in the female, that the coccyx should be preserved in a continuous line with the sacrum, otherwise serious deformity of the pelvis may ensue, interfering with defecation and parturition.   After the reduction has been effected, the parts should be supported with a compress, confined by adhesive strips; perfect quietude and lateral recumbency should be observed; and the bowels, without being acted upon at all frequently, should be maintained in a strictly soluble condition.   Paraplegia and violent neuralgia occasionally follow this accident, owing to injury sustained by the nervous plexus of the pelvis.

2. SUPERIOR EXTREMITY.

FRACTURES OF THE BONES OF THE HAND AND FINGERS.

The symptoms of fracture of the bones of the thumb and fingers are so obvious as to render any formal account of them unnecessary.   The treatment is by a pasteboard, leather, felt, plaster, or rubber splint, accurately moulded to the shape of the member and the palm of the hand, to which it must be well secured by appropriate rollers.

The *metacarpal* bones are sometimes broken by machinery, and I have met with a number of instances in which the fourth and fifth of these pieces had given way under a blow of the fist, the part struck being, in one of the cases, the face, and another the forehead.   Such accidents are characterized by marked displacement upon the back of the hand, from the projection of the anterior fragment, with distinct crepitation and swelling of the soft parts, but hardly any pain.   In young subjects these bones occasionally give way at their epiphyses.   The treatment consists in the use of a well-padded tin case for the palm of the hand, extending from just above the wrist to the ends of the fingers, and of a short, narrow splint for its dorsal surface, firm pressure being made with it over the seat of fracture.   Union generally occurs in a month, with little if any deformity.

Occasionally the fifth bone alone is broken, as I have witnessed in at least half a dozen cases.   The prominent symptom in all was a marked posterior projection.   Great circumspection is necessary in the treatment of this fracture, otherwise deformity will be sure to follow.

The *carpal* bones are never broken, except by direct violence, which always seriously implicates the soft parts, not unfrequently necessitating the removal of a portion, if not of the entire hand.   The nature of the accident is usually apparent from the attendant deformity, the excessive pain, loss of function, and crepitation on manipulation.   Reposition of the fragments having been effected by pressure and counterpressure, retention is secured by means of two splints, ether of binder's board or wood, long enough to extend from the middle of the forearm to the ends of the fingers, the hollow of the hand being well padded, and the limb supported in a sling.

There are no fractures in any region of the body where the surgeon will find a finer field for the exercise of his skill in saving mutilated structures than in those of the hand, thumb, and fingers.   It is here, emphatically, that conservative surgery may often display its highest excellence.   Bad as many of the cases are, there are very few in which, if a proper attempt be made, the parts may not be treated on general principles with a fair prospect of success.   Occasionally a joint may be lost, and still a thumb or finger be of great use to the patient.   It is only in the most desperate cases that primary amputation should be resorted to; in all others an attempt should be made to save the parts.

FRACTURES OF THE SHAFTS OF THE RADIUS AND ULNA.

The radius and ulna may be broken conjointly by direct violence, or, as more frequently happens, by a counterstroke, as when a person falls upon the hand, and the force is concentrated by transmission upon the forearm.   The fracture, although it may occur at any point, is most common in the inferior half of these bones, and rarely takes place at the same level, whatever may be its cause.   In general, too, it is oblique, and not transverse, as is usually supposed.   The nature of the accident is commonly sufficiently apparent

from the angularity of the fragments, as seen in fig. 480, and their preternatural mobility, to say nothing of the facility of eliciting crepitation on rotating the hand. The patient experiences an inability to supinate and pronate the limb, the forearm is in a state of semiflexion, and acute pain is felt at the seat of the injury.

The chief danger in this fracture, as it usually exhibits itself, is from the tendency of the ends of the fragments to sink inwards into the interosseous space, and to become united by a common callus, thereby materially impeding the usefulness of the limb, by destroying the functions of supination and pronation. With ordinary care, however, such an accident is not likely to happen, and, in most cases, the consolidation is completed in from thirty to thirty-five days, without any deformity or ultimate inconvenience. The vicious union here mentioned is well show in fig. 481, from a preparation in my collection.

The fracture having been adjusted in the ordinary manner, the forearm is bent at a right angle with the elbow, and enveloped by a roller extending from the fingers upwards.

Fig. 480.　　　Fig. 481.

Malapproximation of the ends of the Fragments in Fracture of the Ulna and Radius.

Fracture of the Shaft of the Radius, with vicious Union.

Two thick binder's board splints are next applied along the anterior and posterior surfaces of the broken bones, and secured with the remainder of the bandage. They should be a little wider than the limb, and long enough to reach just from below the elbow to the extremities of the fingers, both being well covered with wadding, and accurately moulded to the parts. The hand and forearm are then suspended in a broad sling, with the thumb looking directly upwards.

I have myself for many years entirely dispensed with the compresses upon which so much stress has generally been laid for counteracting the tendency of the ends of the fragments to approach each other at the interosseous space. I am satisfied that all the pressure that can be required, at least in ordinary cases, may be effected by the two splints which are usually employed in the treatment of fracture in this situation. The bandage, too, has received a great deal of unjust blame in these cases, it being alleged that, if applied directly to the surface, it will force the bones together, and thus lead to vicious union. It would unquestionably be easy enough to produce such an effect, but this would be an abuse, and not a proper use, of the bandage, its appropriate office being to afford equable support to the muscles of the broken limb, and to prevent swelling and spasmodic action. Whenever it causes such an amount of compression as to force the fragments towards each other, it cannot fail to excite pain and inflammation, if not worse consequences. It is the manner, then, in which the application is made, and not the application itself, that is objectionable in the treatment of this fracture. As to the splints, they should be carefully moulded to the shape of the limb, a narrow interval being left between them at its radial and ulnar borders. When binder's board splints cannot be obtained, light pieces of wood may be used.

When the fracture is multiple, consisting, for example, of three fragments, the intermediate one, having lost its support, may have a tendency to sink in towards the interosseous space. To counteract this disposition, a thick, narrow pad may be placed along the border of the loose piece, in an opening in the anterior splint, so as to enable the surgeon to make the pressure more firm and direct. But even here such an expedient will rarely be necessary, if the parts have been moulded into their proper position prior to the application of the apparatus.

FRACTURES OF THE ULNA.

Fractures of the ulna may with great propriety be divided into those which take place in its body, its inferior extremity and its two principal processes, the olecranon and coronoid.

1. *Shaft.*—The body of the bone is most commonly broken in the lower half of its

extent, in an oblique direction, as exhibited in fig. 482, from causes acting directly upon the forearm. The accident may, however, be produced by a counterstroke; and at least one instance is known where it was occasioned by muscular action in wringing clothes, the patient being a stout, healthy girl of eighteen. The fracture is evinced by a marked depression at the inner border of the forearm, by the mobility of the fragments, and by the crepitation on rotating the hand. The lower fragment alone is generally displaced, being drawn over towards the interosseous space by the inferior pronator muscle, while the other, from its firm connection with the humerus, remains stationary. An exception to this rule is seen in the adjoining figure.

Fig. 482.
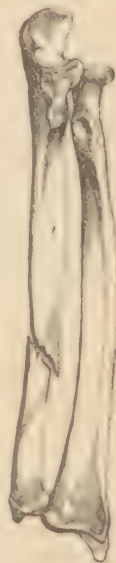
Great care is necessary in the treatment of this fracture, lest the upper end of the lower fragment retains the vicious position into which it is forced at the time of the accident, and so is ultimately soldered to the inner margin of the radius. To prevent this occurrence, the hand should be permanently inclined towards the thumb, by two splints, the extremities of which are rendered somewhat sloping from behind forwards, in a direction opposite to that of the splints sometimes employed in the management of fracture of the corresponding end of the radius. Such an expedient will be much more efficient than the long, thick, narrow compress, generally recommended for that purpose.

The head of the ulna is sometimes broken off, either separately, or along with the head of the radius. The circumstance is easily detected by the mobility of the part, by the disabled condition of the wrist-joint, by the severity of the pain, and by the concomitant distortion. The treatment is conducted with two splints, aided, if necessary, by two compresses applied directly over the seat of the fracture.

2. *Olecranon Process.*—Fracture of the olecranon, fig. 483, is caused either by direct violence, or by the inordinate action of the three-headed extensor muscle, attached to its upper extremity. Of 35 cases collected by Malgaigne, 27 were the result of falls, 3 of blows, and 5 of muscular contraction. Situated at various points of its extent, the fracture may be transverse or oblique, single or multiple, simple or complicated.

Fracture of the Shaft of the Ulna.

Fig. 483.

Fracture of the Olecranon Process.

The symptoms are semiflexion of the limb, impossibility of extending the forearm, a hollow at the back of the elbow, as seen in fig. 484, and a movable prominence at the postero-inferior surface of the arm, along with more or less pain and swelling. The interval between the two fragments varies from one and a half to two inches, and may be augmented or diminished at will by moving the forearm. The radius may be rotated upon the ulna, and crepitation may be elicited by the approximation of the extremities of the broken bone. When the tip of the olecranon is severed, there is no separation of the fragments; and the same thing may happen when the fracture, whether oblique or transverse, is situated above the ligamentous expansion of the extensor muscle.

Fig. 484.

Fracture of the Olecranon Process.

The union of this fracture is generally fibro-ligamentous, as in fig. 485, from a specimen in my collection. The causes of this occurrence are, want of proper nourishment of the upper fragment, difficulty of maintaining apposition, and inordinate deposit of synovial fluid, all, but especially the first, interfering with the healing process. I have, in a few instances, seen osseous union; but this is extremely rare, and is not at all likely to happen if there be any considerable separation of the fragments, or if the fracture extend through the lower part of the process. The period required for the repair of the injury varies

from six to eight weeks; but many months elapse before the patient regains a good use of his limb. When the lesion is of a complicated nature, violent inflammation of the elbow-joint may arise, ending in permanent ankylosis, or in caries and necrosis of the bones.

Fig. 485.
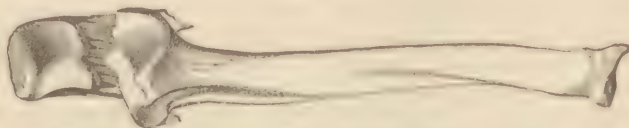
Fracture of the Olecranon Process United by Fibrous Tissue.

The treatment consists in maintaining the limb in an extended position, by means of a wooden splint, long enough to reach from a level with the wrist-joint to within four inches of the shoulder, as represented in fig. 486, from Hamilton. A roller having been

Fig. 486.
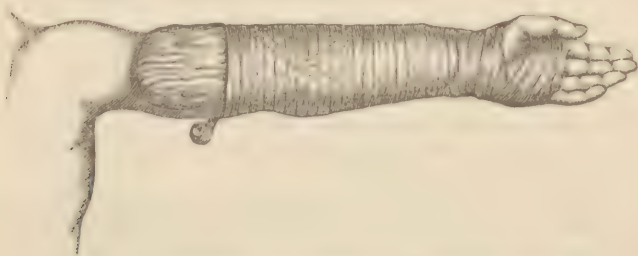
Hamilton's Apparatus for Fracture of the Olecranon Process.

applied from the fingers upward, the small fragment is drawn into its proper place, where it is confined by a few long adhesive strips and a compress, the whole being firmly secured by carrying the roller around the joint somewhat in the form of the figure 8; or, instead of this, the arm is bandaged from the shoulder downwards, so as to obtain a more perfect control over the extensor muscle, the great agent in effecting displacement. Passive motion is instituted at the end of four weeks, and frequently renewed, to prevent ankylosis. When the fracture is associated with severe injury of the soft parts, leeches, fomentations, and other antiphlogistic measures must be employed.

Some practitioners give a decided preference to the flexed position in the treatment of this fracture, and there is no doubt that such a position vastly enhances the comfort of the patient, as it enables him to take out-door exercise and attend to business. The cure, however, is less perfect and at the same time more protracted, owing to the greater difficulty of keeping the ends of the fragments in accurate apposition. Dr. E. A. Clark, of St. Louis, has devised a special apparatus for the purpose, consisting of a band of ordinary sole-leather buckled around the lower part of the arm, and attached by means of two leather straps at the anterior and posterior surfaces of the forearm to a stout buckskin glove. The forearm is well bandaged and supported at an angle of forty-five degrees. A similar contrivance, in which the counterextension is made from the side of the chest by means of adhesive strips, and the apparatus elongated by a ratchet connected with two steel bars, has been invented by Dr. Henry A. Martin, of Boston.

3. *Coronoid Process.*—A considerable number of cases of fracture of the coronoid process of the ulna, fig. 487, have been reported, both in systematic treatises and in

Fig. 487.

Fracture of the Coronoid Process.

medical periodicals, but it is very questionable whether even a minority of them should be considered as true examples of that lesion. I have myself never met with the accident; Professor Hamilton, who has investigated the subject with great care, is very decidedly

of opinion that most of the published cases are unworthy of acceptance, either because they were badly observed or imperfectly reported, and because the existence of very few of them have been verified by dissection. Recently the whole subject has been reëxamined by Dr. R. M. Hodges, of Boston, who has cited a number of examples clearly establishing the occasional occurrence of this fracture. In the case of a boy, nine years of age, treated by Dr. A. A. Scott, of Missouri, to whom I am indebted for the particulars, the coronoid process formed a distinct prominence upon the anterior and inferior surface of the humerus, a short distance above the joint, movable from side to side, the olecranon being at the same time displaced slightly backwards, and the forearm somewhat flexed. The accident was caused by a fall upon the hand while the arm was forcibly extended.

It has generally been supposed that the accident may be caused by inordinate contraction of the anterior brachial muscle; but as this muscle is not attached to the coronoid process, it is impossible for it to produce such an effect. The most reasonable conclusion, therefore, is that fracture of this prominence is always the result either of direct injury, as a fall, a blow, or the passage of the wheel of a carriage, or of force applied to the hand, pushing the ulna and radius violently upwards against the lower extremity of the humerus while the forearm is in a state of extreme extension and the body is impelled in the opposite direction. The accident is usually complicated with fracture, or fracture and dislocation of the elbow-joint.

In whatever manner the fracture is produced, the diagnosis is always attended with unusual difficulty. The ulna, having lost its support in front, will necessarily be drawn backwards and upwards by the action of the three-headed extensor muscle, so that the injury will present all the features of a dislocation of the bone in this direction, the prominence of the olecranon being characteristic. The patient is unable to flex the limb, and the detached portion of bone may be felt immediately above the elbow, where it may readily be grasped and moved about, especially soon after the accident, before any swelling has set in. By bending the forearm at a right angle with the arm, and drawing down the fragment of bone, crepitation might possibly be elicited, but this must, in any event, be very faint and indistinct. The accidents with which the injury is most liable to be confounded are fracture of the humerus and dislocation of the ulna and radius backwards.

The union must always necessarily be fibro-ligamentous, as is sufficiently evident when we reflect upon the small size of the detached fragment, the difficulty of keeping it in place, its imperfect nourishment, and its connection with the joint; circumstances which are so many impediments to the formation of osseous matter. In young subjects, and under proper management, a cure may generally be looked for in four or five weeks.

Apparatus for Fracture of the Coronoid Process.

The *treatment* is conducted with a view to the thorough relaxation of the flexor muscles of the limb. For this purpose, the forearm, after having been properly bandaged from the fingers up as far as the elbow, and the arm from the shoulder downwards, in the opposite direction, is placed at a right angle, as in fig. 488, in a tin case or suitable splints, and supported by a sling, care being taken to prevent the radius and ulna from slipping backwards, away from the condyles of the humerus. The fulfilment of this indication will generally be materially aided by the use of adhesive straps, carried around the joint in the same manner as in fracture of the olecranon. Whatever apparatus be employed, it should be long enough to insure complete immobility of the hand, the fingers being left free. Passive motion should be instituted at the end of four weeks, and perseveringly renewed from time to time, lest ankylosis ensue.

An *epiphyseal* fracture of the extremities of the ulna is an occasional occurrence: for the heads of this bone are not united to the shaft by osseous matter until after the eighteenth year, and often not so soon. The exciting cause is external violence: the symptoms are such as characterize ordinary fracture, except that there is less distinct crepitation, and the treatment, in the upper fracture, is similar to that of fracture of the olecranon, while in the lower two straight splints are required.

FRACTURES OF THE RADIUS.

1. *Shaft.*—Fracture of the body of the radius may take place independently of that of the ulna, as shown in fig. 489, and is the more frequent accident of the two : its most common seat is the inferior half of the bone ; its ordinary cause, a fall upon the palm of the hand. Dr. Packard has reported a case of fracture of the upper portion of the radius from violent muscular exertion in driving a pair of horses.

Fig. 489.

Fracture of the Shaft of the Radius.

The symptoms are usually well marked, there being more or less deformity, preternatural mobility, inability to perform the motions of pronation and supination, and crepitation upon rotating the hand. The ends of the fragments have a singular tendency to approach the interosseous space, and hence, if the case be not judiciously managed, there is apt to be permanent distortion, with partial loss of function of the limb. One of the evil consequences of this tendency is the want of osseous union, or the formation of a false joint within two and a half or three inches of the wrist. A number of well-marked examples of this kind have fallen under my observation, and I know of no fracture where an unskilful surgeon may show his ignorance to greater disadvantage.

The limb, being bandaged in the usual manner, is steadied by two splints extending as far forwards as the extremities of the fingers, the hand being inclined inwards towards the ulna, and maintained in a state midway between pronation and supination. For this purpose, the ends of the splints should be shaped somewhat like the handle of a pistol, as this arrangement will afford an opportunity of bearing upon the radius in such a manner as to force the lower fragment outwards in contact with the superior, thereby counteracting the tendency above alluded to. If this point be strictly attended to, the cure can hardly fail to be perfect. Ordinarily, consolidation may be looked for in four weeks.

2. *Superior Extremity.*—This bone is occasionally broken at its superior extremity, the fracture detaching its rounded head, or extending through its neck. It is very rarely that the bone gives way at the bicipital tubercle. A comminuted fracture is not uncommon, and the injury is then often, if indeed not generally, complicated with fracture of the humerus and serious lesion of the elbow-joint. The accident could hardly be produced in any other way than by direct violence. Owing to the manner in which the parts are enveloped by the muscles, the diagnosis is usually very difficult.

The ordinary symptoms are, deformity just below the elbow-joint, caused by the flattening of the muscular prominence in that situation ; the projection of the upper end of the lower fragment in front of the limb, being drawn thither by the two-headed flexor muscle ; impossibility of executing the functions of rotation ; and the rapid supervention of severe swelling. To render the diagnosis certain, the best plan is to grasp the head of the radius with the thumb and index finger of one hand, and to rotate the forearm with the other. If there be a fracture, its existence will be rendered evident by the head of the bone refusing to obey the motions of the inferior fragment. By adopting this manœuvre, it will hardly be possible to mistake the nature of the case, unless there is so much swelling as to prevent the bone from being felt, in which event the examination must be repeated as soon as the tumefaction has measurably subsided.

In the treatment of fracture in this situation, the limb is placed at a right angle with the arm, in a state midway between pronation and supination, and the same splints are employed as in fracture of both bones of the forearm, care being taken to extend them as high up as possible, in order that they may afford adequate support to the upper fragment. When there is great disposition in the pronator muscle to draw the lower fragment over towards the interosseous space it should be counteracted by a compress.

The annexed drawing, fig. 490, from a preparation in my collection, exhibits a rare form of fracture, in which a portion of the head of the radius has been chipped off, and permanently united to the contiguous border of the coronoid process of the ulna. The specimen was obtained in the dissecting-room, and, therefore, nothing is known of its history.

Inferior Extremity.—The frequency of fracture of the lower extremity of the radius, its liability to be confounded with dislocation of the wrist-joint, and the imperfect recovery

of the functions of the hand which so often follows it, sufficiently attest the importance of the subject, and afford a satisfactory reason for the extraordinary attention that has been accorded to it by modern surgeons. Its literature is voluminous. Among those who have particularly interested themselves in its elucidation may be mentioned Colles, Dupuytren, Goyrand, Diday, Barton, Voillemier, Robert Smith, Busch, Lecomte, Callender, Gordon, Levis, Moore, Wight, Pilcher, Cruce, and Packard. In 1838 Dr. John Rhea Barton described a fracture of the radius involving the wrist-joint, but the existence of which was never, until recently, verified by dissection. The particulars of one such case have been reported by Dr. Butler, of Brooklyn, and of another by Lenoir, of Paris. In 1814 Mr. Colles, of Dublin, gave an account of a fracture which he had repeatedly witnessed at the distance of about one inch and a half above the articulation, and within the last ten years the whole question has been examined anew by some of the French, German, English, and American surgeons, especially the latter, who have contributed valuable suggestions in regard to its mechanism, diagnosis, and treatment.

Fig. 490.

Fracture of the Head of the Radius.

Two circumstances powerfully contribute to the production of this fracture, namely, the large amount of spongy substance in the inferior extremity of this bone, and the peculiarity of its connection with the wrist-joint. The relative quantity of this matter in its lower and middle portions, and also the difference in their compact structure, are very striking. These appearances, which are sufficiently conspicuous even in young subjects, are remarkably prominent in elderly persons, in whom the spongy substance of this part of the bone is generally exceedingly rarefied and infiltrated with oily matter, while the compact is often merely a thin crust, hardly as thick as an egg-shell, and scarcely less brittle. The singular mechanism of the wrist-joint cannot fail to arrest the attention of the surgeon. From the intimate manner in which the radius is articulated with the scaphoid and semilunar bones, any shock received upon the palm of the hand is readily communicated to it, causing it, if the force is at all severe, to give way under its influence; whereas the ulna, which has no such close relation, generally escapes injury.

Fracture of the lower extremity of the radius is most common in elderly subjects, for the reason already stated that this bone is remarkably brittle in advanced life. Young and middle aged persons seldom suffer from it. In children diastasis generally takes the place of fracture. The occurrence is comparatively rare in men.

Respecting the site, direction, and extent of fracture, the greatest possible diversity exists. While in some cases it is within three or four lines of the joint, in others, and these constitute the great majority, it ranges from a half to three-quarters of an inch or even an inch. In what is known as Colles's fracture, the distance is generally estimated at an inch and a half. Occasionally the fracture extends into the joint; and in very rare instances a portion of the articular surface, representing its posterior border, is chipped off, with or without the styloid process. A multiple fracture is by no means uncommon both above and within the joint. In the annexed drawing, fig. 491, from a preparation in the New York Hospital, there are four fragments, and in several cases I have met with five and even six. Occasionally, in fact, the end of the bone is literally ground into pieces. Fig. 492, from a specimen in the Pennsylvania Hospital, kindly lent me by Dr. Longstreth, represents a common form of fracture, both in site and direction, of this portion of the radius.

The *direction* of the fracture is, doubtless, as asserted by Voillemier, Malgaigne, Nélaton, Robert Smith, Levis, and others, for the most part transverse or nearly so, the line of fracture extending either directly from before backwards, across the bone, or from before backwards, and from below upwards, so as to render the posterior surface of the lower fragment considerably higher behind than in front. Cases, however, unquestionably occur, and that not un-

Fig. 491.

Multiple Fracture of the lower Extremity of the Radius.

frequently, in which the fracture is more or less, if not very decidedly, oblique.   Goyrand, who, in 1832, published an admirable memoir on injuries of this kind, broadly asserts that this is uniformly the case, and he has adduced an analysis of 47 cases in illustration of his position.   Whatever the direction may be, the edges of the fragments are nearly always

Fig. 492.
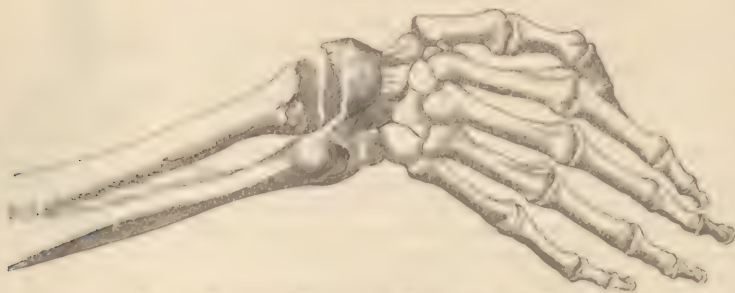
Simple Fracture of the Inferior Extremity of the Radius.

more or less irregular, roughened, notched, serrated, or denticulated.   An impacted fracture is occasionally seen, the most common form being that in which the end of the superior fragment is driven into the cancellated structure of the inferior.   When the force causing the impaction is very great the inferior fragment may literally be crushed by the superior. A double penetration is occasionally observed.   When the interlocking is very firm much difficulty may be experienced in effecting separation and in restoring the parts to their natural relations.

Not a little diversity of sentiment has been expressed by observers respecting impaction in this fracture.   While some actually deny the possibility of its occurrence, others equally entitled to credit do not hesitate to declare that it is very frequent.   Voillemier asserts that impaction is always present, the upper extremity being forcibly impelled into the lower, and he has adduced proof going to show that the impaction is occasionally double, the upper fragment being driven into the lower, and the latter into the former. Nélaton, basing his opinion upon a series of experiments performed upon the dead subject, shares this view.   I have myself no doubt of the occasional existence of impaction: the very mechanism, in fact, of the fracture, or the manner in which it occurs, is sufficient to prove this.   That it is frequent or constant is not true.

Luxation of the ulna is not uncommon in this fracture.   Moore, indeed, thinks that it is present in one half of the cases; but this is probably too high an estimate.   Fracture of the styloid process of this bone nearly always exists in the more severe forms of the accident, especially when the force is received upon the palm and on the inner margin of the hand.   Fracture of the lower extremity of the ulna is then not uncommon.   Displacement, if not actual rupture, of the flexor muscles of the carpus is an occasional occurrence. The carpal ligaments and the interarticular cartilage also not unfrequently sustain serious injury, the latter being sometimes wrenched from its bed.   Finally, the instances are not uncommon in which the radius is broken on both sides, especially in falls from a considerable height in which both arms are outstretched to break the force of the blow.

The accident nearly always results from a fall upon the open hand, in which the patient, stretching out the limb, receives the shock upon the palm, whence it is transmitted to the inferior extremity of the radius.   When the force is expended upon the palm and the ulnar margin of the hand, there will be likely to be, as a serious complication, a luxation of the ulna, either alone or in union with fracture of the styloid process of that bone.   Fracture of the styloid process of the radius will be a probable occurrence, if much of the weight of the body be thrown upon the palm and thenar eminence, or the palm and the thumb. Occasionally, the fracture is caused by a fall upon the back of the hand, or by direct violence, as the passage of the wheel of a carriage.

Fracture in this situation may be complicated, first, with fracture of the styloid process of the ulna, or of the head and shaft of that bone; secondly, with dislocation of the wrist-joint; and, thirdly, with serious injury of the soft parts.   In the case of a young man whom I attended along with Dr. Chenowith, the lower extremity of the radius was split in two by a transverse and an oblique fissure, the larger fragment being completely de-

tached, and thrown forwards and inwards over the ulna, whence, as it was impossible to replace it, I removed it by incision. A good recovery took place, with hardly any impairment of the functions of the wrist-joint. In my private collection is a specimen of transverse fracture of the radius, extending into the joint, and detaching the head of the bone by several small, vertical fissures. In this case I had an opportunity of dissecting the parts after the removal of the forearm, above its middle, by another surgeon, several weeks after the accident. The hand and wrist were much swollen, and infiltrated with pus, which was also freely diffused through the sheaths of the flexor tendons, while the connective tissue along the inner part of the palm contained a good deal of blood. The joint was filled with matter, and the scaphoid and semilunar bones, as well as the ulna, which was dislocated backwards, were almost completely divested of cartilage.

Among the most conspicuous *symptoms* of this fracture is the singular deformity of the hand, giving the limb the appearance of a dislocation of the wrist-joint, as exhibited in fig. 493, or an appearance not unlike the back of a silver fork. This is owing either to the impaction of the upper fragment into the lower, or to the fact that the lower fragment, along with the carpus, is drawn upwards and backwards, from an inch to an inch and a half above the joint, by the force of the injury, or by the continual agency of this force, and of the action of the extensor muscles of

Fig. 493.
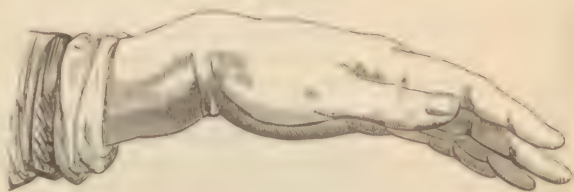
Fracture of the lower Extremity of the Radius.

the thumb, while the upper fragment forms a slight projection on the palmar aspect of the forearm. Immediately above the posterior prominence is a well-marked depression which gradually slopes off towards the ulna, and is generally sufficiently large to receive the little finger. These appearances are always very striking when the limb is held in a situation midway between pronation and supination, and are easily effaced by extension and counterextension, although they are promptly reproduced when these forces are relaxed. The lower extremity of the forearm has a rounded form, from the increase of its antero-posterior diameter; the fingers are usually flexed, and the patient is unable to supinate the hand, which is, moreover, completely powerless; the pain is excessive, and considerable swelling soon arises, especially along the palmar aspect of the limb. Crepitation, except in case of impaction, may commonly be readily detected by rotating the hand upon the lower part of the forearm while the thumb and forefinger of the surgeon are applied just above the wrist-joint. Some surgeons assert that crepitation is never present; this is an error.

Instead of being thrown backwards, the inferior fragment is sometimes forced in the opposite direction, forming a projection in front of the forearm, beneath the flexor tendons. Another tumor, more conspicuous, and consisting of the lower extremity of the superior fragment of the radius, occupies the dorsal surface; it extends across the entire breadth of the limb, and is bounded above by a well-marked furrow, more distinct internally than externally. The accident, which is exceedingly rare, closely simulates dislocation of the carpus forwards, but may readily be distinguished from it by the presence of crepitation, and the facility with which the symptoms may be temporarily effaced under slight manipulation.

Fracture of the inferior extremity of the radius is, perhaps, most frequently liable to be mistaken than fracture of any other bone. The accident with which it is most liable to be confounded is dislocation of the wrist-joint, but from this it can always be easily distinguished by a careful examination and by the fact that a luxation here is one of the rarest of occurrences, while fracture, especially in women and in advanced life, is one of the most common. The singular deformity of the hand is absolutely characteristic, for there is no other accident which precisely resembles it. Crepitation, too, is always easily elicited by grasping the patient's hand and steadying the forearm near its middle, while the radius at the wrist is rotated upon its axis. The deformity is always easily effaced by extension and counterextension, but is immediately followed by recurrence when these forces are relaxed.

The adjoining sketch, fig. 494, represents a fracture of the inferior extremity of the radius, complicated with luxation of the ulna. The signs of both injuries are characteristic. The drawing was taken from a private patient.

The *prognosis* of this fracture is greatly influenced by the nature of the case and the manner in which it is managed. In any event, however, it must, even in its more simple forms, be regarded as a serious accident, often followed, despite the best directed efforts of the surgeon, by permanent deformity and impairment of the functions of the wrist-joint. Although complete consolidation ordinarily occurs in from four to five weeks, several months—commonly from three to six—elapse before the patient regains a good use of his hand and fingers, owing to the remarkable tendency, in all such injuries, in the resulting inflammation to extend to the synovial membrane of the digital articulations, and of the sheaths of the tendons. If the fracture is compound, comminuted, or involves the wrist joint, the danger of permanent impairment of function will be especially imminent. These facts should always be carefully explained to the patient at an early stage of the treatment, otherwise the surgeon may be unjustly censured for what cannot possibly be avoided. Of 92 cases of fracture of the inferior third of the radius, referred to by Professor Hamilton, only 26 are positively known to have left no perceptible deformity or stiffness about the wrist-joint. The adjoining cut, fig. 495, from a specimen in my collection, exhibits a very common species of deformity in badly treated fractures of this portion of the radius. The injury was accompanied by fracture of the styloid process of the ulna. The whole hand is drawn over towards the radial border of the wrist.

Fig. 494.

Fracture of the Lower End of the Radius.

Among the various contrivances that are before the profession for the *treatment* of these fractures, that of Dr. Levis is, perhaps,

Fig. 495.
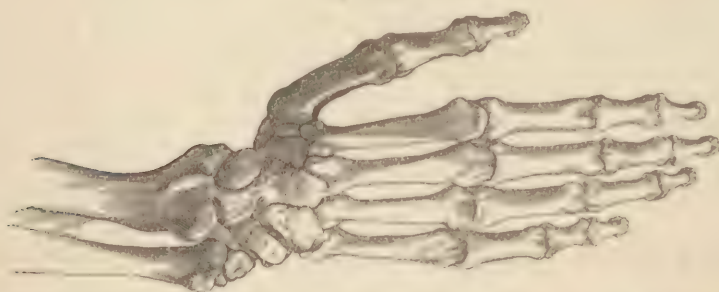
An Old Fracture of the Inferior Extremity of the Radius attended with Separation of the Styloid Process of the Ulna.

the very best and most reliable. That of Dr. Gordon, of Belfast, is also a very superior article, as it admirably fulfils all the indications presented in such lesions. The splints invented by Dr. E. H. Coover, of Harrisburg, Dr. Henry C. Hewit, of New York, and Dr. Carr, of Boston, also merit favorable mention. Dr. Moore's dressing is very simple and effective; and excellent cures, as I know from personal experience, may be obtained from the use of the apparatus of Dr. Thomas Bond, so long in vogue among Philadelphia surgeons. The pistol-shaped splint, said to have been devised by Nelaton, possesses few of the requisites necessary for the successful management of fractures of the inferior extremity of this bone, although Erichsen declares that he has always had excellent results from it. The splint of Dr. Levis, fig. 496, is made of copper, coated with tin to prevent oxidation; it is very thin and flexible, to adapt it to the peculiarities of the size and form of the forearm, ends in a curve in front to receive the palm of the hand, and has a series of little elevations along its edges to keep the bandage used in confining it from slipping. A layer of wadding or flannel serves as a lining; no dorsal splint is required, but in most cases a pad should be placed over the back of the wrist to guard against displacement of the lower fragment. The thumb and fingers are left free, while the anterior extremity of the splint, following accurately the radial curvature, fixes the thenar and hypothenar eminences of the hand in their moulded beds. Fig. 497, shows the manner in which the splint grasps the limb before the application of the roller.

The apparatus of Dr. Bond consists, as shown in figs. 498 and 499, of two splints, one of medium-sized binder's board, and the other of thin, light wood, furnished with a block

Fig. 496.
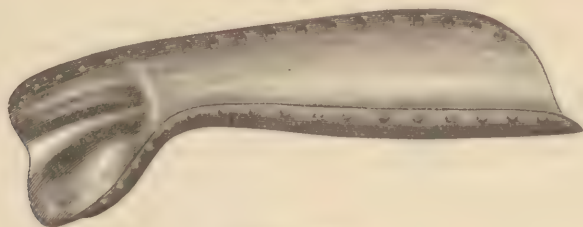
Levis's Splint.

Fig. 497.
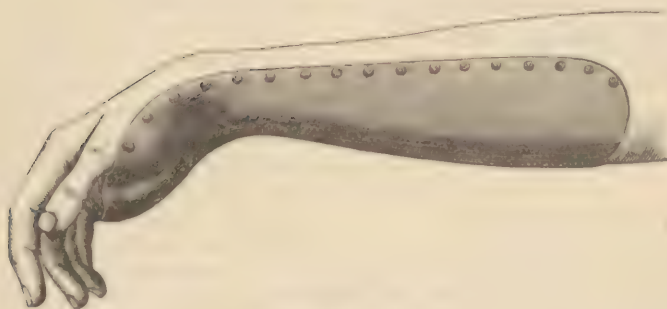
Levis's Splint Applied.

and edges of thin sole-leather, about an inch in height, the whole presenting somewhat the appearance of a shallow trough. They are long enough to reach from a short distance below the elbow to within an inch of the knuckles of the metacarpal bones, the block of the latter resting in the hollow of the palm, and both being well padded with wadding. They are fastened in the usual manner. When there is any marked tendency to displacement, a narrow, square compress, not more than a third of an inch in thickness, may be laid over the projecting fragment, to give greater concentration and effect to the pressure of the apparatus opposite the seat of fracture. Sometimes it is found

Fig. 498.

Bond's splint, for the Back of the Forearm.

Fig. 499.

Bond's Splint, for the Front of the Forearm and Hand.

necessary to use a compress on each side of the wrist; but such is the accuracy with which the palmar splint fits the parts that this portion of the dressing may generally be dispensed with. There is no use, in any case, of an interosseous compress, as there is never any tendency in the fragments to inward displacement. The advantage of the apparatus of Dr. Bond is, as in those of Levis and Gordon, that, while it maintains the thumb perfectly at rest, and, consequently, prevents its extensor muscles from disturbing the fragments, the fingers may be freely moved in front of the block; a circumstance of no trifling importance in an accident so liable to be followed by inflammation and adhesions of the sheaths of the tendons, and ankylosis of the thumb and fingers.

In Gordon's mode of dressing these fractures, the forearm is placed in the prone position, and is supported by a splint, which, to use the inventor's own language, "consists of the body, the ulnar, and bevelled portions, with a curved back splint, fig. 500. The lower end of the ulnar portion is curved forwards and hollowed to receive the inner border of the flexed hand, with a slit for the carpal strap. The bevelled portion is secured

Fig. 500.

Gordon's Splint for Colles's Fracture.

Fig. 501.
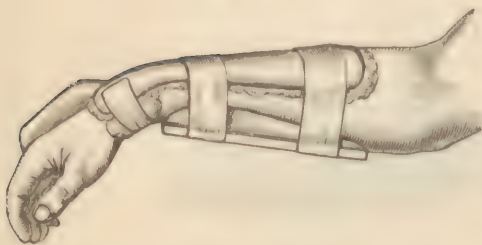
Gordon's Splint Applied.

to the body of the splint nearly half an inch internal to its margin; it is cut off obliquely from without inwards and from below upwards; it is applied to the palmar surface of the upper fragment, which it is its office to fix. The lower end of the back splint is much curved forwards. This curve, with a thick pad, is necessary to enable it to press the base of the metacarpus, the carpus, and the lower end of the lower fragment well forwards for the restoration of the natural aspect of the carpal surface and the concavity of the radius." The dressing is confined with three wide straps, not with a roller, and the forearm is well supported by a sling; when the fracture is only a short distance above the joint, the lower strap is passed over the back of the splint and over the carpus when it is higher up, as in Colles's fracture. Fig. 501, shows the application of the apparatus and the position of the limb.

The dressing of Dr. Moore, fig. 502, consists of a compress from one-half to three-quarters of an inch in diameter and two inches in length, which, after the reduction of the fracture, is placed under the ulna, abutting against the pisiform bone and slowly displacing the thumb, and while the parts are held in position, is confined with a strip of

Fig. 502.

Moore's Method of Treatment. 1. A Cylindrical Compress; 2. Bandage of Adhesive Plaster; 3. Line of Cut in Plaster six hours after the reduction.

adhesive plaster, of similar width, and drawn forcibly around the wrist, its distal edge being brought around on a line with the end of the radius. The operation is completed by suspending the arm in a sling, three inches wide, and so arranged as to bear exclusively on the dressing. The hand is brought down and allowed to hang naturally, its weight and that of the forearm being used to press the ulna upwards into its proper place. Motion of the wrist-joint is counteracted, if necessary, by a light splint stretched along the dorsal surface of the limb. The dressing, which is applied very tightly in the first instance, is relaxed at the end of six hours by thrusting one blade of a pair of scissors underneath it on the back of the wrist, dividing it completely. Dr. Moore's treatment is simplicity itself, and its efficiency has been attested by several eminent American practitioners, among others by Dr. Prince, of Illinois.

Good results may be secured in the treatment of these fractures with two straight splints, extending from near the elbow as far forward as the knuckles of the fingers, the

anterior one being well padded in the part corresponding with the palm of the hand. Compresses should be applied over the seat of the fracture both in front and behind, and the thumb should be made to look directly upward, while the fingers are left unincumbered. In applying the bandage the hand should be slightly inclined toward the ulna. Dr. Barton always obtained excellent cures by the use of two straight splints reaching forward to the ends of the fingers. His plan was to make passive motion at a very early period after the accident.

Whatever splint or apparatus may be used, the cardinal point is to effect thorough reduction of the fracture, by extension and counterextension on the hand and forearm, while the hand is inclined towards its ulnar margin, and pressure is made at the seat of the fracture, so as to force or draw the ends of the fragments into their proper positions. To accomplish this, great difficulty will often be experienced, expecially when the fracture is impacted, comminuted, or associated with luxation of the lower end of the ulna; under such circumstances, indeed, very considerable force is often required to restore the symmetry of the limb. The tendency to displacement, which, however, is seldom great, and often entirely absent, generally ceases of its own accord in five or six days, the muscles becoming, so to speak, reconciled to their new relations. Meanwhile any disposition of the kind must be counteracted by strict attention to the dressings. In children reduction is generally easily effected and maintained. The splints need not be retained, in the adult, longer than five weeks, or four weeks in young subjects. Stiffness of the fingers will not be likely to occur if the movements of their joints be properly attended to during the earlier stages of the treatment.

The treatment of fracture of the inferior extremity of the radius, suggested by Dr. John Swinburne, is very simple and effective. It consists in confining the forearm upon a single splint, stretched along its posterior aspect from the elbow to the metacarpophalangeal joints, and composed of a thin piece of wood of the width of the limb, and provided with two compresses, one of which fills up the concavity of the carpus, while the other supplies the deficiency in the straight line of the arm above. The splint is secured with adhesive strips, the application of which is commenced at the elbow, and continued, at intervals of several inches, down the limb to the hand, which, the displaced parts having previously been adjusted, is then firmly fastened, in such a manner as to allow perfect freedom to the thumb and fingers. Additional support may be given, if necessary, with an ordinary roller. The annexed cuts, figs. 503, 504, and 505, afford a good idea of the apparatus and of the appearance of the limb after its application.

The above dressings answer equally well, whatever may be the character of the displacement, whether backwards or forwards. Passive motion is instituted at the end of three weeks, proper support being given to the fracture while this is being made. The operation is afterwards repeated every other day, until the end of the fifth week, when the apparatus may generally be discontinued, the bandage alone being used. If the joints of the fingers are stiffened, they should receive special attention at each dressing. I have met with cases in which bandaging, douching, and pressure were obliged to be continued daily for many months before the affected joints regained their full motion.

Finally, the radius, in young subjects, occasionally gives way at the lower *epiphysis.* The accident is uncommon, but a number of cases, showing the possibility of its occurrence, are scattered through the records of surgery, and several have come under my personal observation. Voillemier, in experimenting upon the dead body, produced separation at the epiphysis with great facility, simply by forcible flexion or extension of the wrist, not only in young subjects, but, in one instance, in a stout, robust man of twenty-four.

Fig. 503.

Fig. 504.

Fig. 505.

Swinburne's Apparatus for Fracture of the Radius.

The injury, however induced, is managed upon the same general principles as an ordinary fracture of the radius, from which it is not always easy to distinguish it.

FRACTURES OF THE HUMERUS.

Fractures of the humerus are of frequent occurrence, and are of great practical importance, from the difficulty which so often attends their diagnosis and treatment. They may take place in the shaft of the bone, at its surgical neck, at its head within the capsular ligament, and at its condyles.

1. *Shaft.*—The simplest fractures of the humerus are those which occur in its shaft, as they are most easily detected and treated, and least liable to be followed by deformity and loss of function. Caused occasionally by direct violence, they more frequently result from falls upon the palm of the hand, in attempts to save the body from more serious injury. In several instances that have come under my observation, and which are alluded to in another part of this section, the accident was produced by muscular contraction ; in one case, while the patient was in the act of throwing a chip. The fracture is usually oblique, a transverse one, properly so termed, being exceedingly uncommon. A complicated fracture of the shaft of the humerus is occasionally met with, as a consequence of the explosion of firearms, the contact of machinery, or the passage of the wheel of a carriage.

The symptoms of fracture of the humerus in this situation are usually characteristic, the deformity, preternatural mobility, and crepitation being well marked. In general, there is some shortening, the amount varying according to the obliquity of the fracture and the size of the limb ; in ordinary cases it is very slight, the weight of the arm being sufficient to counteract the action of the muscles, at least to a considerable extent. The direction of the displacement is regulated by the line of fracture ; if this be below the insertion of the deltoid, the inferior fragment will be drawn inwards, but outwards if it be above that point. However this may be, any deformity that is present is easily effaced by extension and counterextension. The limb is completely powerless, and is always supported by the patient at the wrist.

The treatment of this fracture is very simple, the only apparatus necessary being two splints, and a roller applied from the fingers up. The splints may consist of two stout pieces of unoiled sole-leather, felt, or binder's board soaked in hot water, and accurately moulded to the shape of the limb ; one extending from the axilla to within an inch of the internal condyle, and the other from the shoulder-joint to the corresponding point of the outer condyle, the two, when applied, nearly meeting each other. The forearm and hand are well supported in a sling ; and, for the sake of greater security, the arm may be fastened by a few turns of a bandage to the side of the trunk. Special care is taken not to raise the elbow, as a certain degree of weight is necessary to prevent overlapping of the fragments.

This apparatus may be advantageously replaced at the end of a week, or as soon as the swelling consequent upon the fracture has measurably subsided, by the immovable dressing. If the tendency to overlapping of the fragments is uncommonly great, a weight, as a few pounds of shot, may be temporarily suspended from the elbow, which, under all circumstances, must be left free. If the dressing be properly applied there is no reason for supporting the forearm with splints, as is urged by Boyer and some other surgeons, in order, as is alleged, to place the brachial muscles in a quiescent condition, and thereby counteract any tendency to displacement. Such a precaution, however, is wise, and cannot be too strenuously insisted upon, when the fracture affects the lower portion of the shaft of the bone, an accident in which there is always unusual danger of overlapping, if the parts be not thoroughly supported and carefully guarded. It is in this portion of the bone in which, if the treatment be not most cautiously conducted, want of union is so liable to occur.

In simple fractures of the shaft of the humerus union may usually be expected by the end of the fifth week. Injuries of this kind are generally readily repaired even in very old persons. Cases are recorded in which consolidation occurred within the ordinary limits at seventy-five, eighty-nine, and even one hundred years, as in an instance observed by Dr. W. W. Dale, of Pennsylvania.

Fractures of the shaft of the humerus are occasionally followed by " wrist drop," dependent upon imprisonment and compression of the musculo-spiral nerve by the callus at the seat of the injury. Two cases of this occurrence have fallen under my observation ; one in a patient of my own, and the other in an out-door patient at the College Hospital. The only remedy is the removal of the offending callus.

2. *Inferior Extremity.*—Fracture of the condyles may be caused by a fall upon the point of the elbow, by a blow, or by the passage of the wheel of a carriage. I have repeatedly known it to be produced by a fall upon the palm of the hand, the limb being at the time in an extended position. The accident may be simple, or, as not unfrequently happens, complicated with serious mischief to the joint and soft parts. Both condyles may be broken, as in fig. 506, or one only may be affected. In the former case, a longitudinal fracture usually extends some distance along the centre of the bone, and then terminates, probably an inch and a half to two inches above the joint, in an oblique or transverse fissure in the lower portion of the shaft of the humerus, thus producing three fragments. Not unfrequently, however, there is a separation merely of one of these prominences, the fracture being then usually directed obliquely downwards into the joint. In a third series of cases, the small projection, the internal epicondyle as it is termed, is broken off, either obliquely or perpendicularly, without any involvement whatever of the articulation.

Fig. 506.

Fracture of the Condyles of the Humerus.

Fracture of the condyles, especially when it affects only one of these prominences, is almost invariably an accident of early life, the great majority of cases occurring before the fifteenth year. Occasionally an instance is met with in old age, in consequence of the inordinate brittleness of the osseous tissue.

The symptoms of fracture of this portion of the humerus vary according to circumstances, as might be expected from a consideration of the structures of the elbow-joint. When both condyles are severed just above the articulation, the radius and ulna project backwards, a hollow exists at the bend of the arm, the forearm is slightly flexed, and the distance between the elbow and wrist is sensibly diminished. When the fracture involves both the condyles and the inferior extremity of the shaft of the bone, there will be, in addition to these phenomena, an increase in the width of the bend of the arm, and an appearance of greater flattening. The accident, whether accompanied by this occurrence or not, is liable to be mistaken for dislocation of the radius and ulna backwards; but the diagnosis may generally be readily determined by the fact that the symptoms which mark the former lesion promptly disappear on extending the limb, and that crepitation may be produced when the forearm is rolled upon the humerus.

Fig. 507.

Fracture of the Internal Condyle.

When the inner condyle alone is detached, as in fig. 507, the ulna projects backwards, but resumes its natural position on extending the limb; the condyle forms a tumor at the back part of the elbow; crepitation is perceived on bending the forearm; and, if the forearm be extended, the humerus will advance in front of the ulna as the latter recedes.

Fracture of the external condyle, fig. 508, is characterized by the existence of a tumor at the outer and back part of the elbow, by crepitation on rotating the radius, by the supine position of the hand, by the inability to move the joint, and by the constant semiflexion of the forearm.

Fig. 508.

Fracture of the External Condyle.

Whatever may be the nature or extent of these fractures in the vicinity of the elbow-joint, there is always severe pain, with complete inability to move the limb. Considerable swelling soon follows, and effusion rapidly takes place within the articulation, obscuring the characteristic features of the injury, and rendering the diagnosis proportionately difficult. When such a condition exists, leeches, fomentations, and other antiphlogistic measures may be necessary before the parts will be sufficiently tolerant of the requisite manipulation.

The inferior extremity of the humerus occasionally gives way just above the condyles, generally in a more or less oblique direction, as seen in fig. 509. Such an occurrence may, unless great care be taken, be readily confounded with dislocation of the ulna and

Fig. 509.

Fracture of the Lower End of the Humerus.

radius backwards, which its symptoms, at first sight, closely resemble. The signs of distinction are the mobility of the limb and the facility with which the parts can be restored to their natural position, followed by the immediate return of deformity upon discontinuing the extension. The accident, which should be treated on the same principles as fracture of the shaft of the humerus, is extremely liable to be succeeded by stiffness of the joint.

In children, prior to the completion of the ossific process, there is sometimes a separation of the *epiphysis* of the inferior extremity of the humerus, induced by falls upon the hand or elbow. The symptoms resemble those of fracture in this situation in the adult, there being an unnatural projection at the back of the joint, caused by the retraction of the lower fragment along with the bones of the forearm, and the ready production of crepitation on extending the limb. The accident is treated as if it were a fracture.

Fractures of the inferior extremity of the humerus, involving the elbow-joint, are peculiarly liable to be followed by severe inflammation of the synovial membrane, extensive effusion, ankylosis, and deformity. Even in the more simple forms of these injuries, where the treatment is most skilfully conducted, there is generally great risk of an unfavorable result, and in any event a long time must elapse before there will be a good use of the articulation. A prudent surgeon should, therefore, at once inform his patient of the nature and probable consequences of the case. From five to six weeks is the average period necessary for the reunion, which, unless the apposition is most perfect, will occasionally be fibro-cartilaginous instead of osseous.

Fig. 510.
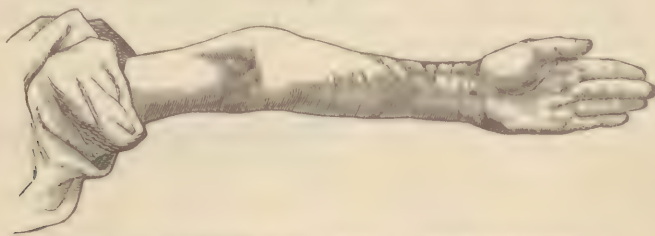
Badly-treated Fracture of the External Condyle of the Humerus.

The nature of the deformity, in badly-treated fracture of the condyles of the humerus, may exhibit itself in a variety of ways, depending upon the peculiar mode of management. Sometimes a posterior projection remains, caused by the backward displacement of the lower end of the bone; not unfrequently the limb has a strangely twisted appearance, either in the direction of pronation or supination; occasionally it is permanently flexed or extended; and sometimes, again, it is greatly increased in breadth. A very common form of badly-treated fracture of the external condyle is exhibited in fig. 510, from a clinical case.

Most practitioners are agreed upon the propriety of treating these fractures with the forearm in the rectangular position. There are but few that pursue the opposite plan, and the arguments that have been adduced in its favor have by no means convinced me that it is at all equal to the ordinary method. To maintain the limb in the flexed position, I have long been in the habit of employing a light, well-shaped tin case, extending from the axilla to the metacarpo-phalangeal articulations. This, being properly lined with wadding, affords an admirable support to the limb, and effectually prevents displacement of the fragments, whatever may be their size or number. The skin over the inner condyle must be well protected from pressure, otherwise it may become seriously inflamed, if not ulcerated. To obviate this occurrence, a small gap should be made in the apparatus for its special accommodation. A case made of India-rubber, felt, thin wire, sole-leather, or plaster of Paris answers quite as well as one of tin, and is even, in some respects,

superior to it, inasmuch as it admits of more accurate adaptation to the irregularities of the limb. The forearm is supported in a sling, in a state midway between supination and pronation.

The rectangular splint, originally recommended in the treatment of these fractures by Physick, is still capable, when judiciously used, of rendering good service in this class of cases. The best contrivance of the kind, however, is that of Professor Agnew, in which the two pieces are united by hinges, thus permitting the angle of flexion to be regulated at pleasure. There is some diversity of opinion as to whether the splint should be applied to the outside or inside of the limb. My own experience is that the advantages are decidedly in favor of the latter, provided an opening be left at the elbow for the accommodation of the epicondyle, which should always be carefully protected from harm, whatever apparatus be employed. Excellent cures may be effected, especially in young children, by applying the splint in front of the limb, so as to concentrate the pressure at the seat of the fracture.

Dr. Oscar H. Allis, of the Presbyterian Hospital of this city, recently called attention to the importance of treating fractures of the lower extremity of the humerus in the extended position. Having enjoyed uncommon facilities for the study of injuries of this kind, he is convinced that much better cures can be effected in this than in any other way. The inflammation consequent upon the accident having been reduced, suitable means, as a splint of felt, binder's board, or unoiled sole leather is moulded to the anterior surface of the arm and forearm, and confined by means of the egg-paste dressing, the bend of the elbow having been previously well covered in with cotton or some other soft material. Three layers of bandage are generally amply sufficient. The extended position is maintained until complete consolidation has taken place, usually from three to four weeks and a half, according to the age of the patient, when a more convenient position is assumed, and the limb carried in a sling, passive motion being now for the first time attempted. Dr. Allis assures me that his success with this treatment, extending over many years, has been most gratifying, and he has adduced a number of cases, going to show that the deformity of the limb, illustrated in fig. 510, is a very common occurrence when fractures of the condyles of the humerus are treated with the forearm in the flexed position, but may be readily prevented in the extended.

Fracture of the tubercle of the internal condyle—the so-called *epicondyle* of the French anatomists—is by no means a rare occurrence, especially in very young children, and is generally caused by direct injury, as a fall or blow upon the elbow. Prior to the completion of the ossific process, it is sometimes occasioned by sudden and violent muscular contraction. The direction of the fracture is usually more or less oblique. Not unfrequently the lesion is complicated with dislocation of the radius and ulna upwards, or with fracture of the inner condyle. When it exists as an independent affection, it does not, of course, extend into the joint, although it is liable, even then, unless properly treated, to be followed by ankylosis.

Fig. 511.

Fracture of the Epicondyle.

The diagnosis is readily established by the great mobility of the fragment, represented by the epicondyle, by the easy production of crepitation, and by the other ordinary signs of fracture. The fragment either retains its natural position, or, as is more generally the case, it is pulled down a short distance over the forearm, occasionally almost in a straight line, but more commonly to one side, by the action of the flexor muscles. The movements of the joint are more or less impaired, and, when the accident has been caused by external violence, there is often a considerable amount of ecchymosis.

Although the small fragment may generally be readily restored to its normal position, great difficulty is experienced in keeping it there until it has regained its former attachments. For this reason it is always well to give a guarded prognosis, as few cases recover without a certain degree of deformity or even ankylosis.

The treatment is by the rectangular case, with an opening opposite the inner condyle to ward off pressure, the limb being carefully bandaged from the fingers up, and the epicondyle confined by adhesive strips and compresses. Passive motion must be commenced at the end of a month, and afterwards repeated daily until all danger of ankylosis is over. Now and then the cure is best effected with the limb treated in the straight position.

No example, of a reliable character, of fracture of the external epicondyle has ever been recorded. Indeed, the very possibility of such an occurrence is generally denied, surgeons in the most extensive practice having never met with any cases of it.

There are no fractures which require more constant vigilance after their adjustment

than those about the elbow-joint. The dressings should, therefore, during the first week, be frequently examined, in order that they may be promptly changed in the event of their being either too tight or too slack, and special pains must be taken that the bandage, in the first instance, be applied rather loosely, due allowance being always made for the resulting swelling. As a general rule, the best plan is to reduce the inflammation consequent upon the injury, as a preliminary step, by placing the limb in the extended position upon a pillow, and keeping the parts constantly wet with a strong solution of lead and opium. The first five or six days may generally be well spent in this manner. Passive motion should not be instituted until complete union is obtained, after which it should be repeated, at first every other day, and then daily, until all danger of ankylosis is over. At this stage, too, it is highly important that the limb should be released from the constrained position which it occupied during the treatment, being gradually extended if it was flexed, and flexed if it was extended.

Fractures of the elbow are often of a *complicated* character, as in fig. 512, especially when caused by railway injury, or falls from a great height, penetrating the joint, exten-

Fig. 512.

Complicated Fracture of the Elbow.

sively lacerating the soft parts, and, perhaps, comminuting the bones. Such accidents are always fraught with danger, both to limb and life, and usually promptly require amputation. Even supposing that the limb could occasionally be saved under such circumstances, the patient's recovery will be extremely tardy, and when, at length, he does get well, it will be found, as a rule, that the joint will be worse than useless, only serving as a hindrance. Resection is sometimes admissible in these injuries; but, as a principle, amputation is altogether preferable, especially when they are accompanied by extensive laceration of the soft parts.

In the treatment of these fractures about the elbow great comfort is derived from placing the limb upon a pillow arranged along the patient's side; or, what often answers a better purpose, a Stromeyer's cushion, a triangular, wedge-shaped appliance, about fifteen inches in length by six inches in width, and four inches in thickness at its inferior extremity.

Fig. 513.

Stromeyer's Cushion, with Straps applied.

It is secured to the limb and to the neck by suitable straps, and to the body, if necessary, by several turns of a roller. Fig. 513, from Bryant, affords a good idea of this very excellent apparatus.

3. *Superior Extremity.*—The superior extremity of the humerus includes the hemispherical head of this bone and its two necks, the anatomical and surgical; the former being the narrow, constricted portion between the head and its tuberosities, and the latter all that portion which intervenes between these prominences and the insertion of the broad dorsal muscle, its length varying from an inch and a half to two inches, according to the stature of the individual.

a. *Fracture of the Head.*—Fracture of the head of the humerus is so extremely uncommon that its possibility was for a long time a matter of controversy among surgeons. The cases, however, that have been reported by Bichat, Astley Cooper, Dorsey, Gibson, R. W. Smith, Malgaigne, and others, have effectually dispelled all doubt upon the subject. I saw, myself, during my pupilage, in a patient of Dr. George McClellan, an instance of the kind, which had been mistaken by the attendants for a fracture of the acromion process, and the true nature of which was not detected until several years after the occurrence of the accident, when the man, who was upwards of forty years of age, died of disease of the liver. The fracture, as was shown on dissection, had extended obliquely from above downwards through the head of the bone; and, although it had become perfectly consolidated, there were several rough prominences which, while they unmistakably indicated the seat of the injury, greatly impeded the movements of the shoulder-joint. The accident had been caused by a fall from a carriage.

In a specimen in my private collection, obtained from the body of an insane woman, upwards of seventy years of age, whose skeleton had been broken in numerous places, in a fall from a second-story window, the head of the humerus is completely detached from the anatomical neck, the articulating surface, which retained its smooth and polished aspect, being tilted over the great tuberosity against the posterior surface of the bone, to which it is firmly and inseparably united by osseous matter, the fracture having evidently occurred a long time before death.

Directly opposite to the prominence thus formed, on the inner surface of the humerus, is another large projection, fully an inch in length, having the character of a stalactitic exostosis. The bicipital groove is completely effaced. The whole bone is extremely light, its weight being hardly two ounces and a half. The annexed cut,

Fig. 514.

Fracture with Detachment of the Head of the Humerus.

fig. 514, conveys a good idea of the distinguishing features of this remarkable, if not unique, specimen.

When the head of the humerus is completely detached from the tubercles along the anatomical neck, it must necessarily act as a foreign body, speedily perishing from the want of nourishment. In some cases, however, it is enabled to preserve its vitality, although imperfectly, by retaining its connection with the rest of the bone through the intervention of a few bands of fibrous tissue.

β. *Fracture of the Anatomical Neck.*— In old persons, the head of the bone, fig. 515, is sometimes not only broken off, but thrown down into the axilla, where it forms a distinct tumor that may easily be felt by the hand, but which does not obey the movements of the arm. Such an occurrence, which occasionally happens in the act of reducing a shoulder dislocation, always seriously complicates the case. The accident is generally caused by a fall on the elbow, or by violence applied directly to the shoulder, and is very liable to be mistaken for other injuries.

The intracapsular fracture of the humerus is occasionally impacted, the upper fragment being propelled into the inferior or conversely. The occurrence, which is extremely uncommon, is met with exclusively in old subjects, laboring under atro-

Fig. 515.   Fig. 516.

Fracture of the Anatomical Neck of the Humerus.

Fracture of the Anatomical Neck of the Humerus, in which the Head of the Bone is turned upside down.

phy and great fragility of the osseous tissue. The head of the bone can be felt in the glenoid cavity, there is a slight hollow below the acromion process, the axis of the arm is directed inwards towards the coracoid process, and the elbow is somewhat separated from the trunk. Crepitation is either very faint or entirely wanting. The length of the humerus is diminished, but generally in so slight a degree as to render it unavailing in a diagnostic point of view.

Fig. 516, from a specimen in my collection, represents an ancient fracture of the anatomical neck of the humerus, in which the head of the bone, united by a thick layer of osseous matter, is turned upside down, the centre of the articular surface corresponding with the outer border of the shaft. Several stalactites, one of large size, had been developed immediately below the head. The joint was of course completely annihilated. Such a case would have formed a proper subject for excision.

γ. *Fracture of the Surgical Neck.*— Fracture of this portion of the humerus is uncommon, but may take place from the same causes as fracture of the shaft of the bone, as a fall upon the hand or elbow, direct violence, or, although rarely, from muscular action. The injury is always attended with marked displacement, forming an important feature in its history. The superior fragment, yielding to the influence of the spinate muscles of the scapula, is generally drawn outwards and slightly backwards, while the inferior one is

directed inwards towards the side of the trunk by the pectoral, broad dorsal, and large teres muscles, attached to the inner border of the bicipital groove. At the same time that

Fig. 517.

Fracture of the Surgical Neck of the Humerus.

this portion of the humerus is dragged inwards, it is usually somewhat raised by the joint agency of the muscles that pass from the scapula to the forearm ; the extent of the displacement, however, is commonly trivial, inasmuch as the weight of the limb is almost sufficient to counteract its occurrence.

Fig. 518, from a specimen in my cabinet, affords a good illustration of a badly-treated fracture of the surgical neck of the humerus, followed by exuberant callus, as must always be the case when the ends of the fragments are not kept properly in place.

The diagnosis of these different fractures is not always so easy as might, at first, be supposed. Their character is often greatly obscured by the swelling, and the consequent

Fig. 518.

Badly United Fracture of the Surgical Neck of the Humerus with Exuberant Callus.

difficulty of making a thorough examination. In general, there is marked deformity at the shoulder-joint, the deltoid muscle is flattened, the arm is twisted upon its axis, and, if the injury is situated on the outside of the capsular ligament, there is usually slight shortening of the humerus, with distinct projection of the upper end of the lower fragment. If extension and counterextension be made, so as to draw the parts in place, crepitation may be elicited, followed by a recurrence of all the previous symptoms the moment the surgeon relinquishes his hold. In cases of doubt, the best plan is to grasp the head of the humerus firmly with the thumb and fingers of one hand, while with the other we seize the elbow and move the arm on its axis. If fracture be present, it will almost be sure to be detected by the crepitation produced by this manœuvre, whereas, if there be a dislocation, no noise will be perceived, and there will also be little or no mobility. When the head of the bone is fractured, and thrown off the glenoid cavity, the symptoms will be of a compound character, the crepitation and abnormal mobility coexisting with flattening of the deltoid muscle, extraordinary saliency of the acromion process, and a remarkable fulness in the axilla, caused by the presence of the displaced bone, at the same time that the upper extremity of the inferior fragment projects prominently upwards and inwards.

Treatment.—Fractures of the superior extremity of the humerus must all be treated upon the same general principles as fractures of the shaft of the bone. The limb being bandaged from the fingers up, two splints, broad and hollow, made of unoiled sole-leather, binder's board, gutta-percha, or gum sheeting, are applied, one on the outside and the other on the inside of the limb, the former being long enough to extend from the external con-

Fig. 519.

Welch's Shoulder Splint.

dyle to the top of the shoulder, which it should cover well, as in fig. 519, as it is designed to give firm support to the broken parts. The inner splint should be thickly padded at its superior extremity, otherwise it may chafe the skin or exert undue pressure upon the axillary vessels and nerves. No cushion will be required for the axilla. The arm is carefully secured to the side of the chest, and the forearm is supported in a sling, but the elbow is left free, in order that its weight may counteract the tendency to overlapping of the fragments. Passive motion is instituted at the end of the fourth week, and firm union may reasonably be expected in a fortnight more. A long time, however, will elapse before the joint will completely regain its functions, if, indeed, it ever do. Permanent lameness will be inevitable, if the fracture be intracapsular and comminuted, owing to the difficulty of readjusting the fragments.

When fracture of the superior extremity of the humerus is complicated with dislocation, the proper plan, of course, is to restore the displaced bone to its natural position before any attempt is made to adjust the ends of the fragments. The operation, however, will necessarily be one of extreme difficulty, on account of the shortness of the superior piece, which thus deprives the surgeon of the advantage of a suitable lever. His whole reliance must, therefore, be upon well-directed pressure and counter-

pressure, while the patient is fully under the influence of an anæsthetic, complete muscular relaxation being essential to success. When the operation fails, it has been recommended to let the dislocated head of the bone remain in its unnatural situation, and to bring the upper extremity of the lower fragment in contact with the glenoid cavity, in the hope that, in time, as the bone becomes rounded off, it will contribute to the restoration of the motion of the limb. Such an idea, however, it seems to me, must be perfectly delusive; for it is impossible, under such circumstances, for nature to make a good or useful joint. Instead, therefore, of pursuing such a practice, I should not hesitate, if a case of the kind were to present itself to me, to cut down upon the dislocated bone, and push it back into its natural position; or, if this be impracticable or deemed inexpedient, and the head of the bone be found to compress the axillary plexus of nerves, to perform excision.
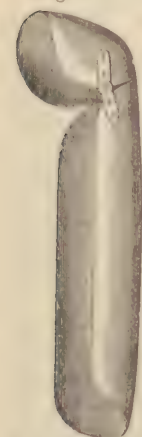
Fractures of the surgical neck of the humerus are occasionally impacted, the upper extremity of the inferior fragment being forcibly driven into the cancellated structure of the superior, or conversely. Such an occurrence is most common in old subjects, after the age of fifty-five, in consequence of interstitial absorption of the osseous tissue, and may be produced either by a blow upon the shoulder, or, what is more common, by a fall upon the elbow. The extent of the impaction varies from a few lines to half an inch or more. As the bone retains its continuity, the symptoms of the accident are usually very obscure, there being neither mobility nor crepitation, unless the fragments are unlocked by being pulled forcibly asunder. Nevertheless, there is generally some deformity perceptible upon firmly grasping the humerus, and an alteration in the axis of the limb, which often looks as if it were twisted together with severe pain, and usually also more or less contusion of the soft parts. If the impaction is extensive, there will, in addition, be some degree of shortening of the arm, or a slight diminution in the distance between the shoulder and elbow. These circumstances, conjoined with the fact that the patient has received a severe injury, that there is loss of motion in the joint, and that all the symptoms of dislocation are absent, afford sufficient evidence of the probable nature of the case.

The impacted fracture requires no special treatment on its own account. To pull the fragments forcibly asunder would only produce mischief and trouble. Instead of such interference, the surgeon contents himself with supporting the limb, and combating inflammation by leeching, fomentations, and other means. In due time passive motion is instituted, lest ankylosis of the shoulder-joint should arise.

δ. *Great Tuberosity.*—Fracture of this portion of the humerus, although uncommon, is probably not as infrequent as is generally supposed, the obscurity of its symptoms rendering it extremely liable to be mistaken for other lesions in and around the scapulo-humeral articulation. The accident may occur at almost any period of life, except, perhaps, in early childhood, and is usually caused by a fall or blow upon the forepart of the shoulder, the force being concentrated upon the upper extremity of the humerus so as to separate the large tubercle from the hemispherical head and shaft of the bone. Pitha, Theden, and others, have met with cases in which the detachment was caused by the violent contraction of the two spinate and small teres muscles.

The existence of the fracture is denoted by considerable flattening of the deltoid muscle, by a remarkable increase in the width of the upper portion of the arm, which is nearly double what it is in the natural state, and by the presence of two osseous prominences, one of which, consisting of the detached tuberosity, is situated at the superior and outer part of the joint, and the other, formed by the head of the humerus, at the upper and inner part. The acromion is abnormally salient, and the arm is separated from the side, but may be approximated to it without difficulty, and readily rotated in every direction by the surgeon.

The diagnostic signs most worthy of reliance, are the great increase in the breadth of the articulation, the refusal of the thumb to sink into the glenoid cavity, as it always does in dislocation of the shoulder, the preservation of the length of the limb, and the production of crepitation upon rotating the humerus by seizing it just above the elbow while the surgeon encircles the head of the humerus with both hands. Another important evidence is that the deformity is readily effaced by manipulation, but instantly reappears when it ceases.

Repair, generally of an osseous character, is effected in from four to six weeks, according to the age of the patient, the immobility of the fragments, and the amount of the resulting inflammation, which is always very considerable from the contusion of the soft parts. The motions of the joint, in consequence, remain imperfect for many months; and in not a few cases, even when the greatest vigilance is exercised, they are never com-

pletely regained, owing to a redundancy of callus and the formation of osseous excrescences around the articular surfaces.

In the *treatment* of this fracture, one of the leading indications is to neutralize the action of the muscles which are attached to the tubercles of the humerus, the larger one receiving the insertion of the two spinate and the small teres, and the lesser the subscapular, which necessarily tend to draw the fragments away from each other, the subscapular being materially aided in this way by the action of the broad dorsal, the great pectoral, and the short head of the flexor of the arm. To accomplish this object, the limb should be put up in two felt, leather, or binder's board splints, the inner of which is nicely padded above to prevent undue pressure upon the axillary vessels and nerves, while the outer is bent well over the top of the shoulder. No cushion will be necessary, especially if the arm and forearm are properly secured to the chest. The elbow is supported in a sling, but not so firmly as to push the head of the bone too high up towards the acromion process. For the first five or six days after the accident, leeches and fomentations may be required. Passive motion should be instituted at the end of four or five weeks.

Fractures of the humerus, especially of the superior part of the bone, are often attended with a remarkable disposition to overlapping of the ends of the fragments from the action of the muscles of the arm and chest, particularly the great pectoral, and great teres, which generally draw the upper fragment inwards and backwards more or less away from the lower broad dorsal. In most cases, however, the tendency rapidly disappears spontaneously, as the irritation of the muscles subsides, so as to permit the fragments to fall into their natural position. The ordinary dressings are generally quite sufficient to keep the parts in apposition, provided the elbow is permitted to hang free and the forearm is well supported, the weight of the arm thus counteracting any tendency to displacement. I have, indeed, never witnessed an instance in which there was any trouble of this kind. If such a contingency, however, should arise, it could readily be remedied by attaching a weight to the lower extremity of the arm by means of adhesive strips, as suggested by Dr. E. A. Clark. The extension apparatus of Dr. Henry A. Martin, consisting of a splint, stretched along the posterior surface of the limb, and regulated by a ratchet operating on two steel bars, might also be worthy of trial.

Epiphyseal Fractures of the Head of the Humerus.—The epiphyseal fracture of the head of this bone is always caused by direct violence, as a blow or fall upon the shoulder, and is peculiar to early life, rarely occurring after the fifteenth year. It has been well described by Sir Astley Cooper, Mr. Robert Smith, Dr. Hamilton, and, above all, by Dr. Moore, of Rochester.

The symptoms, which are generally characteristic, are preternatural mobility of the limb, faint crepitation, even when the ends of the fragments are rudely rubbed together, the retention of the head of the humerus in its normal position, a marked projection below the coracoid process, formed by the upper extremity of the shaft of the bone, and a depression at the distance of about half an inch below the acromion process. The shoulder-joint, viewed in profile, is slightly flattened and increased in breadth. The motions of the arm are more or less impeded.

The diagnosis hinges mainly on the tender age of the patient, the indistinctness of the crepitation, which is much less than in fracture, the preternatural mobility, and the lodgment of the head of the humerus in its normal situation. The upper extremity of the shaft of the bone projects in front of the joint, and, instead of being sharp and angular, as in fractures, is convex, and comparatively smooth. When the parts are displaced, there is shortening of the arm, the elbow hangs off from the side, and the hand cannot, without difficulty, grasp the sound shoulder; all these phenomena being reversed when the fragments remain in apposition. The shortening seldom exceeds half an inch. Any deformity that may exist is readily effaced by extension and pressure, but recurs the moment these efforts are relaxed. The accident is liable to be confounded with dislocation of the shoulder-joint and fracture of the head of the humerus and of the scapula.

The reduction is effected by extension, aided by manipulation, and is maintained by an apparatus similar to that used in fracture of the superior extremity of the humerus. A thick compress should be placed over the inner side of the joint to prevent displacement of the upper extremity of the shaft of the humerus. In neglected cases, the limb eventually, in great degree, regains its normal usefulness, the lower fragment being gradually rounded off, and the capsular ligament elongated.

3. INFERIOR EXTREMITY.

FRACTURES OF THE FOOT.

Fractures of the bones of the foot do not require any special notice, as their management is conducted upon the same principles as that of fractures of the hand. From the fact that they are generally complicated, the treatment must be largely antiphlogistic, and the surgeon will have cause to congratulate himself if he is not occasionally obliged to amputate the foot, or exsect some of its bones. Any loose and displaced fragments, if they cannot be moulded into shape, should always be promptly removed, even when there is no external wound; for such pieces would not only act as foreign bodies, but might, in the event of vicious reunion, seriously interfere with the wearing of a boot. Simple fractures of the toes and metatarsal bones are best managed with the immovable dressing, with the addition of thin binder's-board splints to afford proper support at the seat of injury.

The *calcaneum*, or heel-bone, notwithstanding its exposed situation, the importance of its functions, and the manner in which it lies beneath the tibia and fibula, is seldom the subject of fracture. Direct violence is the most common cause of the accident, which is often attended with severe lesion of the neighboring structures, both soft and hard. Falling from a great height, in which the person alights upon his heel or foot, is the manner in which it commonly happens. The bone being thus forcibly acted upon, on the one hand by the weight of the body, and on the other by the resistance offered by the surface struck, yields at its weakest point, breaking, perhaps, into several pieces. More rarely the accident is produced by the inordinate contraction of the muscles of the calf, as in dancing and leaping; but in this case it is only the posterior extremity of the bone that suffers, its tip being the part generally torn off. The amount of displacement varies according to circumstances, being necessarily very slight when the fracture extends across the body of the bone, whereas it is always very considerable when it involves its back part, on account of the action of the gastrocnemial muscles, which, exerting their influence through the tendo Achillis, sometimes draw up the posterior fragment from an inch and a half to two or even three inches. An impacted fracture of the calcaneum has been met with, but is extremely uncommon.

The symptoms of this fracture are always sufficiently characteristic when the posterior portion of the bone is broken off, the hollow at the heel, the protuberance at the lower and back part of the leg, and the impossibility of flexing the foot, being unmistakable evidences of the nature of the accident. Upon bringing down the upper fragment in contact with the inferior, crepitation may be obtained, although it will be very faint if only the tip of the bone has been detached. The diagnosis will be more difficult when the fracture extends across the body of the calcaneum; for then there will be no displacement, the lateral and interosseous ligaments keeping the posterior fragment in position. In general, however, it may be determined by the history of the case, and by making pressure upon the calcaneum in different directions, thus eliciting crepitation if fracture actually exist.

A fracture of the calcaneum from the laceration of its fibres is usually slow in healing, on account of the difficulty of keeping the fragments in contact, the muscles of the calf constantly tending to separate the upper from the lower. For this reason the union is generally ligamentous, and a long time is necessarily required for the complete restoration of the functions of the foot. When the fracture is caused by direct violence, the repair is effected in the ordinary manner.

When the accident is accompanied by much contusion of the soft parts, antiphlogistics should be freely used before the permanent dressings are applied. The nature of these dressings must depend upon the presence or absence of displacement. In the former case, the chief obstacle to the cure is the contraction of the gastrocnemial muscles, which must, therefore, be effectually controlled until the consolidation is sufficiently advanced to enable the upper fragment to maintain its position independently of extrinsic aid. The least objectionable contrivance for this purpose is a short splint, of perforated zinc, well padded, and adapted to the shape of the limb, the anterior part of which it should cover from the middle of the leg nearly as far as the toes. When zinc cannot be obtained, wood, felt, sole-leather, or binder's board may be used. The object of this splint is to maintain the leg and foot in a permanently flexed position, to relax the muscles of the calf. To maintain the upper fragment in place, the leg and foot may be bandaged in opposite directions, adhesive strips and a compress having previously been applied around

the heel and sole. This position should be observed for at least six weeks, or until the connecting medium is firmly established. When the tendency to displacement is very great, the division of the tendo Achillis may become necessary. The apparatus of Petit, formerly so popular in the treatment of this form of fracture, is worse than useless, as the tendency of the cord and slipper is to separate the upper fragment and to irritate the soft parts about the heel.

In the other variety of fracture, as there is no displacement, all that is necessary is to subdue inflammatory action, and to keep the foot and leg in a quiet and relaxed position with a tin case, or two light side splints, the limb lying upon its outer surface over a pillow, with a proper support for the foot.

Fracture of the *astragalus* is very uncommon, especially the simple variety; the accident is generally complicated with fracture of the tibia and fibula, severe injury of the soft parts, and dislocation of the fragments. The latter lesion existed in eight cases out of ten of fracture of the astragalus collected by Dr. Monahan.

In consequence of the severe injury inflicted in this accident upon the foot and leg, primary amputation will frequently be required. If this be neglected, the patient may perish from erysipelas, mortification, pyemia, or hectic irritation. When the fracture is complicated with dislocation, without serious lesion of the ankle-joint and the soft parts, an attempt should be made, by extension, counterextension, and pressure, aided, if necessary, by the subcutaneous division of the resisting structures, to restore the fragments to their proper position; if this fail, excision must be performed.

FRACTURES OF THE TIBIA.

The tibia, like other long bones, is liable to give way at various points of its extent, but more frequently below its middle than anywhere else. A fracture of its condyles is unusual, and its occurrence is always denotive of great direct violence. Occasionally the bone is broken near its upper extremity, from an inch to an inch and a half below the knee. The internal malleolus is sometimes detached by a twist of the ankle, by a fall upon the sole of the foot, or by direct injury.

The ordinary cause of fracture of this bone is external violence, as a blow or fall. A fracture of the tibia from a fall upon the foot is by no means uncommon. The bone sometimes gives way under muscular action, especially in very old subjects, in whom the osseous tissue is often unusually rarefied and brittle. Complicated and comminuted fractures of the tibia are more frequent than in any other piece of the skeleton.

Fig. 520.

An instance of intrauterine fracture of the tibia, in the sixth month of pregnancy, caused by violent pressure upon the abdomen, has been reported by Dr. Proudfoot, of New York. Madame Lachapelle saw a case of separation of the upper epiphysis of this bone, from traction of the child's foot during parturition; and Dr. Voss met with an example of diastasis of the inferior epiphysis from a fall in a lad fourteen years of age.

Most fractures of the shaft of the tibia are oblique, very few, if any, transverse; nevertheless, as the fibula retains its integrity, there is seldom any considerable displacement, the sound bone acting as a splint to the broken one. It is not often, however, that the fragments completely retain their apposition; in general, there is some degree of separation, which may always be easily detected, even when there is a good deal of tumefaction, by passing the finger along the tibia, and tracing its outline. If there be a fracture, it will manifest itself by an abnormal depression at some particular point, or by an unnatural projection, sufficiently obvious to establish at once the nature of the case. The amount of this projection is occasionally very great, especially when the upper fragment is very long, sharp, and oblique, in which event it is generally extremely prominent, and with difficulty prevented from piercing the skin. The annexed drawing, fig. 520, from a preparation in my collection, conveys a good idea of this form of the injury. For the reason just mentioned, there will usually be very little, if any, crepitation. The fracture, if perfectly free from complication, unites in from four and a half to five weeks.

Oblique Fracture of the Tibia.

A peculiar form of fracture of the tibia, originally described, in 1855, by Gosselin, under the name of the V-shaped, cuneiform, or spiroidal fracture, although infrequent,

is worthy of special notice on account of the gravity of its prognosis. In this country attention was first directed to it by Dr. R. M. Hodges, of Boston. It is often, if not generally, associated with fracture of the fibula, and usually occurs at about the junction of the middle with the lower third of the tibia, the line of fracture representing the form of the letter V, with the base looking upwards, while the apex terminates in a fissure which extends obliquely or spirally down around the shaft of the bone, into or near to the ankle-joint. The mechanism of the injury is not well understood, and there are no signs by which it can be distinguished from an ordinary fracture in this situation. The prognosis is always grave, the lesion, especially if compound, as it generally is, being very liable to give rise to erysipelas, pyemia, and osteomyelitis from exposure of the medullary canal. Fatty emboli, in a putrid state, have been repeatedly found in the lungs of persons dead from the effects of the injury. The only safety of the patient, as experience has clearly shown, in compound V-shaped fractures of the tibia, is in prompt amputation of the limb.

Fracture of the internal malleolus is met with in various forms. In some cases, the process is broken off at, or close to, its connection with the lower end of the tibia; in others, near its articular extremity; but the most common site of the lesion is about the centre of the process. Its direction is nearly always oblique; rarely, if ever, strictly transverse or perpendicular. Occasionally the process is comminuted or broken at several points. Finally, cases not unfrequently occur in which the fracture coexists with fracture of the lower extremity of the fibula. The diagnosis is easily established by the position of the foot, which is always turned upwards and inwards, as if it were partially dislocated, and by the facility with which the detached piece of bone may be moved about with the thumb and finger; a procedure which also readily elicits crepitation.

The most simple contrivance for the *treatment* of fracture of the tibia is a tin case, fig. 521, accurately shaped to the limb, provided with a foot-piece, and reaching a few inches above the knee. A bandage is applied in the usual manner, and any tendency to displacement is easily counteracted by means of a compress and a short splint, arranged so as to bear gently and equably upon the ends of the fragments. I have never found it necessary to employ any other apparatus than this, no matter where the tibia was broken. When the fracture involves the malleolus the foot-piece will effectually prevent displacement. In fracture of the superior extremity of the tibia, extending into the condyles, the plan usually adopted is to place the leg and thigh in the straight position, so as to compel the condyles of the femur to support the broken bone, extension and counterextension being made with two long splints. Such a contrivance, however, will be entirely unnecessary if the tin case be employed, especially if it be sufficiently long to embrace the inferior third of the thigh, as it will thereby completely counteract any tendency in the muscles of the limb to draw the upper fragment backwards into the popliteal space. An efficient appa-

Fig. 521.

Tin Case.

ratus for these fractures will also be found in Dr. Welch's splints, fig. 522; and in the wire splints of Dr. Bauer, fig. 523, the latter being particularly valuable on account of their light, airy, and pliable character.
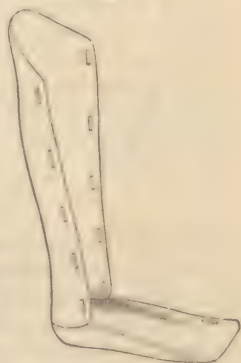
Fig. 522.

Welch's Splints.

Mr. John Croft is a warm advocate of the treatment of fractures of the leg, whether of one or of both bones, by the use of two plaster of Paris splints, carefully adapted to the

sides of the limb, and applied as soon as possible after the infliction of the injury. He does not hesitate to adopt this method even when there is considerable inflammation of the soft parts, as evinced by discoloration or discoloration and the development of vesicles, provided the circulation is unimpaired. Mr. Croft's position of surgeon to St. Thomas's

Fig. 523.
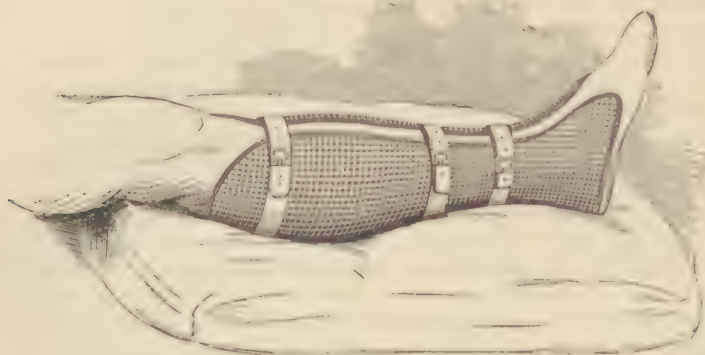
Bauer's Wire Splits.

Hospital, one of the largest institutions of the kind in the world, justifies him in taking high ground in relation to this mode of management, especially when he can back up his experience by an appeal to 587 cases thus treated without any ill results. Professor Little, of New York, is also an advocate of this method of treatment in a modified form.

The sharp point of bone which occasionally remains after fracture of the shaft of the tibia, in consequence of the inordinate projection of one of the ends of the fragments, generally, in time, disappears through the agency of the absorbent vessels, the parts becoming softened, rounded off, and entirely harmless. When the projection is very considerable, causing pain and ulceration of the skin, and resisting the usual remedies, the best plan is to remove the offending structures with the surgical engine, or the pliers and chisel, as I have done with excellent effect in several instances.

FRACTURES OF THE FIBULA.

Fracture of the fibula is, relatively considered, a sufficiently common occurrence, its frequency being due apparently to the slender form of this bone, to its superficial situation, and, above all, to the important part which it plays in the formation of the ankle-joint. The accident may take place at any portion of the bone, but is by far most common in the inferior fifth of its extent, owing to its intimate connection with the astragalus, which, constituting the pivot of the foot, readily receives and transmits the various shocks to which the latter is so continually exposed. Of fractures of the shaft and head of the fibula no particular description is necessary, since they are always easy of detection, and the treatment does not differ materially from that of similar injuries of the tibia. But it is different with fractures of the inferior fifth of the bone, where, as just stated, the lesion is most common, and where, from being usually associated with other mischief, it is extremely liable to be followed by deformity and permanent lameness. For these reasons, fractures in this situation require to be studied with more than ordinary care.

Fractures of the fibula are much more common on the right side than on the left. In 207 cases collected by Dupuytren, more than two-thirds involved the right leg. The statistics of Malgaigne show that it is most frequently met with between the ages of twenty-five and fifty, and that men are more than four times as liable to it as women. Of 104 cases examined by this author, not one occurred before the fifteenth year.

The causes of fractures of this portion of the fibula can only be properly appreciated by a careful examination of their mechanism. The tibio-tarsal articulation, being a hinge-joint, admits only of flexion and extension, its lateral movements being restrained by the two malleoli, and the ligaments by which the bones of the leg are connected with those of the foot. Hence, the latter cannot be turned outwards or inwards to any considerable extent without producing a fracture of the former, the site of injury being determined by the particular inclination of the limb. Thus, when the foot is forcibly abducted, its inner edge resting on the ground, the upper surface of the calcaneum will be pressed violently

against the external malleolus, in a direction parallel to the fibula, which will, consequently, yield at its weakest point, which is about an inch and a half above the joint, at the part sometimes called the neck of the bone. In most cases there is a rupture of the deltoid ligament, if not also a fracture of the internal malleolus. When the foot is forcibly abducted, the astragalus becomes the immediate cause of fracture, for this bone, turning upon its antero-posterior axis, escapes from the arched cavity formed by the tibia and fibula, and, pressing against the outer malleolus, breaks the fibula nearly at the same level as in the preceding case, the direction of the fissure being usually somewhat oblique. The external lateral ligament is either torn or violently stretched.

The most ordinary cause of this fracture is a fall upon the foot, in which this portion of the limb is forcibly inclined laterally, at the moment the weight of the body impels the bones of the leg forcibly against those of the foot, rendered stationary by the resistance offered by the ground. The fibula may also be broken across by violence applied directly to the part, as a blow, or the passage of the wheel of a carriage. Of 207 cases of this accident, recorded by Dupuytren, 120 were the result of forcible adduction, and 60 of forcible abduction, the rest being caused by direct violence.

However the fracture may be induced, the superior extremity of the inferior fragment is always thrust inwards against the tibia, while the inferior extremity of the superior fragment either remains fixed, or inclines in the same direction. The latter usually happens when the injury is direct, the former when it is indirect.

The inferior extremity of the fibula is sometimes broken almost vertically; such an occurrence, however, must be extremely uncommon, and I have seen only two instances of it, both of them being in the Mütter collection. In one, represented in fig. 524, the bone looks as if it had been split, the fissure extending upwards, almost in a straight line, fully an inch and a half; the posterior, longer, and larger fragment being pushed considerably backwards, so as to form with the other an intermediate triangular space. In the other bone the fracture is also vertical, but the separation is much less.

The *symptoms* of fracture of the lower extremity of the fibula vary according to the circumstances of the case. When this bone alone is severed, the chief signs will be slight eversion of the foot, a depression at the site of injury, and some change, usually not very conspicuous, in the contour of the ankle-joint. When the internal malleolus is broken off, or when the tibia has given way a short distance above the articulation, these characters will exist in a more marked degree, and point out unerringly the nature of the lesion. The foot will be so much abducted as to present the appearance of being dislocated outwardly; the width

Fracture of the Fibula.

between the two malleoli will be much increased; the hollow at the line of fracture will be quite deep; and the external margin of the foot will be considerably elevated, while the internal will be proportionately depressed. Upon taking hold of the foot, it will be found that it is unusually movable, and that it can easily be restored to its natural relations, but that the moment the grasp ceases it will return to its former position. In performing these manipulations, crepitation is very easily perceived; and, upon tracing the outline of the lower portion of the bone, the finger usually sinks in at the seat of fracture, owing to the fact, previously mentioned, that the upper end of the lower fragment always falls over towards the tibia. A good deal of ecchymosis is often present, and a considerable amount of swelling quickly follows, obscuring the characteristic features of the injury, and embarrassing the diagnosis. The only accident with which fracture of the inferior extremity of the fibula is liable to be confounded is a sprain of the ankle-joint, from which, however, it may always readily be distinguished by the great distortion which attends it, and by the presence of crepitation.

A simple fracture of the fibula in the inferior fifth of its extent will, if properly treated, usually unite in a month, without any deformity of the limb, although even then a considerable time will elapse before the ankle-joint will perfectly regain its functions. When the injury is complicated with rupture of the ligaments, fracture of the corresponding portion of the tibia, or other serious lesion, the repair will be much slower, and there will be danger, unless the case be managed with the most consummate skill, of permanent deformity and lameness, the former manifesting itself in an everted condition of the foot and in increased width of the ankle-joint.

The material point in the *treatment* of fracture of the fibula in this situation is to maintain the foot in a position the reverse of that which it assumes in consequence of the

injury. To accomplish this object, which is designed to draw away the upper extremity of the lower fragment from the tibia, and to restore it to its proper relations, the limb, after having been enveloped in the ordinary bandage, with the precaution of not compressing it opposite the site of fracture, is placed in a tin case, the foot being directed permanently inwards. The requisite inclination may easily be imparted by means of a piece of roller, or a few adhesive strips, carried around the instep and heel, and attached to the inside of the leg. Or, instead of this, the fracture may be treated with Dupuy-

Fig. 525.

Dupuytren's Apparatus.

tren's apparatus, fig. 525, consisting of a light wooden splint and a wedge-shaped cushion, the former reaching from the upper third of the leg to about three inches below the sole of the foot, and the latter from the same point to a level with the ankle. The limb being bandaged in the same cautious manner as in the former case, the apparatus is stretched along its inner surface with the tapering end of the pad upwards, and secured, first above, and then below, the roller being passed around the foot and ankle in such a manner as to turn the internal margin of the foot upwards and inwards. The limb may afterwards be kept in the extended position; or, what is preferable, placed, half bent, upon its outer surface, over a large pillow. The parts are diligently watched, the dressing being changed as occasion may require, and passive motion instituted at the end of the third week, and diligently repeated for many months. The ankle-joint always remains weak long after the fracture has become consolidated, from an extension of the inflammation consequent upon the injury.

FRACTURES OF BOTH THE TIBIA AND FIBULA.

Fractures of both bones of the leg are sufficiently common, particularly in young and middle-aged subjects, and are deserving of special attention, on account of the difficulty of their management, and their liability to be followed by deformity and lameness.

Much diversity obtains in regard to the seat of these fractures, as well as their direction, and the nature and extent of their displacement. In twenty-two specimens, contained in the Mütter collection and my own, I find that in ten the tibia and fibula were broken at their inferior extremity, the line of separation in none of them extending beyond three inches above the joint. In four the tibia gave way at its lower third, and the fibula at from two to three inches and a half from its head, or junction with the upper end of the tibia. In six of the cases the tibia was broken from two to three inches above its inferior articulating surface; in two of these the fibula had yielded at its middle, and in the remaining four at different points of its extent. In only two cases had both bones been broken at the same level; in one of these the fracture occurred at the middle of these pieces, and in the other a little below that place.

In the twenty-two cases here referred to, the tibia had been broken only twice above its middle; whereas the fibula had given way above this situation in six cases. In sixteen of the cases the seat of fracture of the tibia was either at the ankle-joint, or below the middle of the bone, generally in its inferior fourth or third. In ten cases of fracture of the fibula the seat of the injury was either at the joint, or within the first three inches from its articulating extremity.

From the above examinations it follows, first, that the tibia and fibula rarely break on the same level; secondly, that both bones are most liable to yield either at the ankle-joint, or within the first three inches above that point; and, thirdly, that the fibula is more frequently fractured at its superior extremity than the tibia.

An examination of these specimens has supplied me with some other interesting facts. Thus, I have found that the fracture in nearly all was more or less oblique, the line of separation in fifteen specimens of broken tibia extending from above downwards, and from without inwards. As a natural consequence of this occurrence, the superior extremity of the inferior fragment projected outwards towards the fibula, which it touched in several of the preparations, on account of a want of proper adjustment during the treatment; the lower extremity of the upper fragment, on the contrary, projected inwards, and had, apparently, generally been much the sharper of the two. The fibula, in most of the specimens, afforded evidence of having been broken across more abruptly

than the tibia, but still with a considerable degree of obliquity in almost every instance that I inspected.

In recent fracture of the tibia, complicated with fracture of the fibula, the inferior extremity of the upper fragment is generally remarkably sharp, and, consequently, often projects through the skin at the time of the injury, the same cause that produces the lesion forcing it across the soft parts. Or, if it is not pushed out at the moment of the accident, it frequently escapes afterwards, through ulceration, induced by the pressure which it exerts upon the overlying structures. The obliquity of fractures of the tibia is often very extraordinary, and there are few instances in which it does not become a source of great suffering to the patient, and of annoyance to the surgeon, on account of the trouble that is experienced in keeping the parts in their proper relations. This is more especially the case when the fracture, situated at the lower fourth of the tibia, is directed from above downwards and forwards, in consequence of the constant tendency of the muscles of the calf to draw the inferior fragment backwards and upwards. When the direction of the fracture is reversed, the extremity of the inferior fragment projects forwards, riding over the lower end of the upper fragment. In either event, the fracture is often rendered compound by the pressure of the sharp extremity of the bone against the soft parts.

A rare form of fracture of these two bones is represented in fig. 526, from a specimen in my collection. The tibia was broken off immediately above its articulating surface with-

Fig. 526.
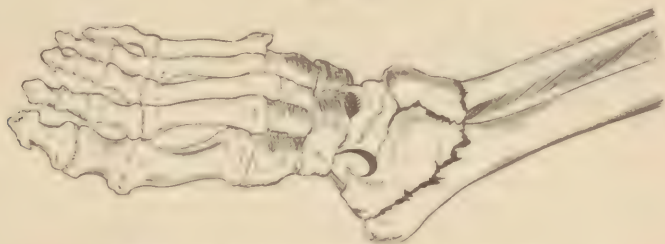
Fracture of the Tibia and Fibula at the Ankle-joint.

out affecting the internal malleolus, while the fibula had given away about an inch and a quarter above the joint. The foot was characteristically everted. In fig. 527, also from a specimen in my possession, the fracture was comminuted, and extended into the ankle-joint, the articular surface of the tibia having been broken into several pieces, one of which embraced the internal malleolus. The fibula had given way about two inches above its inferior extremity.

The most common causes of this accident are falls, as in slipping upon the ice, or when the foot is suddenly caught in a hollow, or between two hard, resisting objects, so as to throw the whole weight of the body upon the leg. In a case, recently under my observation, both bones gave way just above the ankle by the foot being caught in the fold of the carpet. It may also be caused by a fall from a considerable height, in jumping out of a carriage under full speed, and by direct violence, as the kick of a horse, the caving in of a sand-bank, or the fall of a heavy stone. An instance of fracture of both bones of the leg by muscular action, in a man forty-two years old, has been recorded by Hevlbard D'Arcy.

Fig. 527.

Fracture of both Bones of the Leg at the Ankle-joint.

The *symptoms* of the injury, however induced, are generally well marked, if not positively unmistakable. In nearly every case the limb is shortened from one and a half to three inches, and there is also, generally, great deformity in its diameter, both depending upon the overlapping of the fragments, which, as already stated, is frequently very extraordinary. Besides, upon making extension and counterextension, it is generally easy to elicit crepitation. When the fracture is very oblique, the lower end of the superior fragment may usually be felt immediately beneath the integument, forming a sharp, prominent projection either in front of the limb, or at its inner aspect. Sometimes the soft structures are much bruised and ecchymosed. Another remarkable symptom, one, indeed, which is seldom absent, is a spasmodic twitching of the limb, coming on soon after the accident, and frequently lasting for several days or even weeks, much to the annoyance and distress of the patient.

When the fracture is situated just above the ankle, the foot is usually a good deal everted, causing an appearance of dislocation outwards, as exhibited in fig. 528, and con-

Fig. 528.

Fracture of the lower End of the Tibia and Fibula.

stituting what is usually known as Pott's fracture. In this form of the injury the fibula is broken at a distance of one and a half to two and a half inches above the joint at the same time that the astragalus is dislocated from the tibia, in consequence of the rupture of the internal lateral ligament, either alone or in conjunction with fracture of the inner malleolus. The foot is everted, not by the action of the long peroneal muscle, but by the vulnerating force, which renders that muscle powerless.

The prognosis of fracture of both bones of the leg may be gathered, in part, from what precedes. In the more simple forms of the injury, attended with but little obliquity, a good cure may generally be effected in from four to five weeks. If, however, the obliquity is uncommonly great, it will be extremely difficult, if not impossible, to effect consolidation in a manner altogether unexceptionable, no matter with what skill and attention the treatment may be conducted. More or less deformity will almost be inevitable, either in the length or in the diameter of the limb, owing to the remarkable tendency of the ends of the fragments to overlap each other, which it is often impossible to counteract successfully by any means that can be adopted for the purpose.

Fractures of the tibia and fibula, like those of the bones of the forearm, are occasionally connected by a bridge of callus, or of new osseous matter, which does not, however, as in the latter, so far as can be determined, impair their usefulness. I have several times met with this occurrence when the lesion was confined to one of these bones; and I have noticed that it is not necessary to its production that there should be any approximation of the ends of the opposite fragments, as it may occur when they are perfectly straight, although any considerable displacement no doubt acts as a predisposing cause.

Treatment.—The treatment of fracture of both bones of the leg, attended with shortening of the limb, must be by extension and counterextension, steadily and persistently maintained throughout, otherwise, as just stated, deformity will almost be inevitable. If, on the other hand, the fracture is transverse, or nearly so, such a procedure may of course be dispensed with, the object being attained by confining the leg in a tin case, or fracture-box, care being taken to keep the great toe constantly on a line with the inner border of the patella, the surest evidence that there is no rotation of the ends of the fragments upon each other. Any tendency to forward, backward, or lateral displacement is generally easily counteracted by means of compresses and short splints, aided, if necessary, by the elastic bandage. The limb may then be placed in an easy position upon a slightly inclined plane, made of a bolster or pillow, or it may be suspended by a cord and pulley to the tester of the bed, as may be found most agreeable or convenient.

Fig. 529.
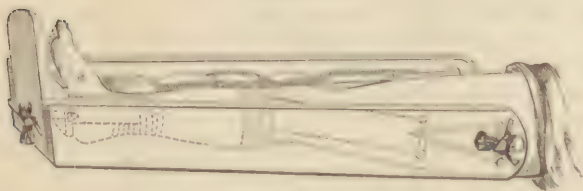
Dr. Neill's Apparatus for Fracture of the Leg.

Counterextension may be made when the fracture is oblique by means of a box provided with a foot-board, and two lateral splints, one extending to the perineum, and the other to the axilla, as I have generally myself preferred; or, with the contrivance of Dr. Neill, consisting of a box, reaching as high as the middle of the thigh, counterextension being made with adhesive strips, passed through holes at the upper part of the apparatus, and tied on the outside, as exhibited in fig. 529.

The use of the gaiter, fig. 530, in the treatment of fractures of the leg and thigh, attended with shortening and deformity, cannot be too pointedly condemned, as it is almost impossible, in any case, however carefully watched, to prevent chafing, and other inconvenience. A similar remark is applicable, only more forcibly, to the handkerchief, fig. 531, at one time so much employed for this purpose. Both appliances should be proscribed, especially as an admirable substitute may always be found in adhesive strips,

secured to the sides of the limb, as in fig. 532, and at the bottom of the foot to a piece of board about four inches in length and three in width. From this board extends

Fig. 530.

Application of the Gaiter.

Fig. 531.
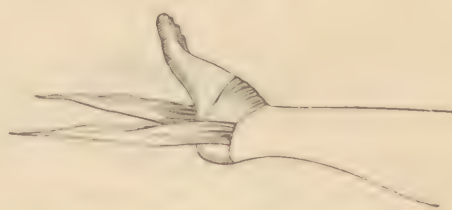
Application of the Handkerchief.

a cord which plays over the pulley in the stand, fig. 533, or over the apparatus, fig. 534, devised by Dr. Levis, and attached to the foot of the bed. The requisite weight may be obtained by a bag of shot, piece of iron, or the elegant contrivance of Levis, fig. 535.

Fig. 532.

Application of Adhesive Strips for making Extension.

Fig. 533.   Fig. 534.   Fig. 535.

Stand and Pulley for making Extension in Fractures
of the Lower Extremity.

Levis's Stand and Pulley.

Perforated one-pound weights
for Extension.

The annexed cut, fig. 536, represents the method of treating oblique fractures of the leg, recommended by Dr. Swinburne. A narrow, delicate splint and foot-piece are fastened by means of adhesive plaster, while counterextension is made from the knee by strips of the same material looped about the limb below the joint. A strong cord is then passed through this loop, and thence on through a hole in the side splint, opposite the lower part of the thigh, in order to afford the requisite degree of tension. If, after the apparatus has been applied, the limb is not sufficiently steady, adhesive strips must be used as represented in the engraving.

Suspension of the leg may sometimes be advantageously practised, both as it respects

the comfort of the patient and the welfare of the fracture. This may be done either according to the method recommended, many years ago, by Professor N. R. Smith, or by

Fig. 536.
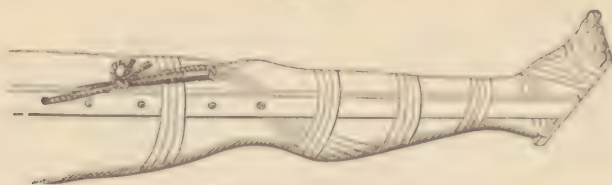
Swinburne's Apparatus.

the very simple contrivance of Mr. Salter, of England, depicted in fig. 537, representing the limb surrounded by the apparatus and slung to the tester of the bed. The case in

Fig. 537.
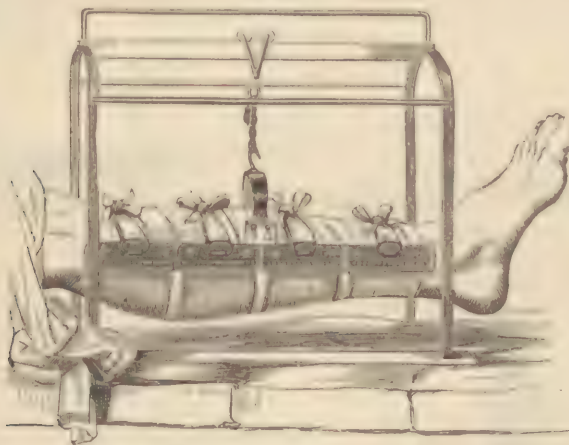
Salter's Apparatus for Suspending the Leg.

which the leg rests is made of light metal; and the whole contrivance is so arranged as to admit of lateral motion, as well as of sliding up and down, simply by the rolling of the pulley-wheels upon the horizontal bar. The attachment of a foot-piece would greatly improve the apparatus, as the limb could then be more effectually steadied.

The apparatus of Dr. N. R. Smith may be used for fractures of any of the long bones of the lower extremity, whether simple, compound, or complicated. It consists, as is seen in

Fig. 538.
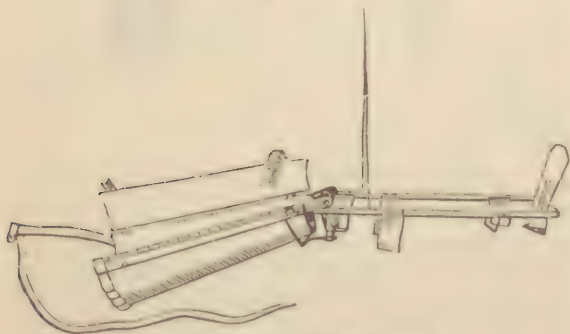
N. R. Smith's Suspending Apparatus.

fig. 538, of two pieces, united by a hinge, after the fashion of a double inclined plane, one corresponding with the thigh, and the other with the leg, the latter supporting a shoe, which is attached by a thumb-screw, and is so arranged as to be rotated outwards or inwards, thereby elevating or depressing the toe, as may be deemed most desirable. The two pieces are supplied with side-boards, joined by the bows of iron beneath; and they are so constructed, both at the knee and at the foot, that they may be elongated or shortened at pleasure. Moreover, a short crutch, movable and well padded, is secured to the inner and upper extremity of the thigh portion, in order to prevent injurious pressure upon the perineum. Another piece, also well padded, movable, and composed of iron, is appended to the superior and outer part of the apparatus, and is fastened around the

trunk by a strong band. The thigh and leg rest on slings attached to the side pieces, the latter being confined in the apparatus by its own weight, aided by a bandage, while the former is supported in front by a well-padded, flexible splint. The whole contrivance is suspended to the ceiling, or to the tester of the bed, by a single cord, attached below the knee, near the centre of gravity of the limb and apparatus. The cord ascends with a slight obliquity from the trunk, so as to effect the requisite extension, by making gentle traction on the limb, which is completely grasped by the apparatus, and consequently firmly held by it. In this manner, the member is compelled to obey all the accidental and necessary movements of the body, thus obviating all strain and tension at the seat of fracture.

In Pott's fracture, the plan of treatment which I have usually found most efficacious is to place the limb in the extended position in a tin or wire case provided with a vertical foot-piece. To counteract the tendency to displacement, a short splint should be stretched along the inner surface of the limb, and secured by means of adhesive strips or several turns of a roller. Mr. Pott thought that deformity was due to the action of the muscles of the leg, and hence his invariable practice was to lay the limb upon its outer side, with the knee moderately bent. My opinion is that this is not the fact, but that the weight of the foot is the direct, if not the only, cause of the displacement, especially after the first few days, and that the difficulty is most easily counteracted by keeping the foot well supported during the after-treatment. Any tendency that may exist in the muscles to produce displacement usually subsides within a few days after the accident.

COMPLICATED FRACTURES OF THE LEG.

Fractures of the leg are not unfrequently complicated, whether involving both bones or only one, as in fig. 539. In the latter case, the tibia, much more frequently than the fibula, is the piece that is most liable to suffer. Such accidents are produced in various ways; sometimes by violence applied to the foot, as when a man jumps out of a second-story window, or falls from a scaffolding; but more generally by direct force, as the passage of the wheel of a carriage, a blow from a stone, or the kick of a horse. When pro-

Fig. 539.
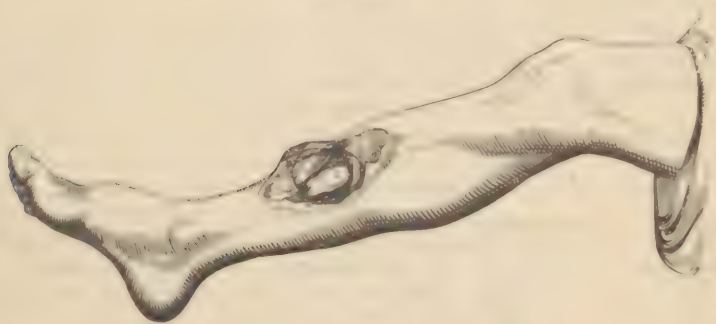
Complicated Fracture of the Leg.

duced by these and similar causes, the lesion is usually situated in the inferior portion of the leg, towards the ankle-joint, which is not unfrequently penetrated. Fractures of the leg, occasioned by railway violence, are always of a comminuted character, the bones being extensively crushed, and the soft parts severely lacerated and contused, if not actually pulpified. Hemorrhage, both venous and arterial, often sadly complicates such injuries, and, along with the shock, sometimes proves speedily fatal, the system, perhaps, never fairly reacting after the accident. Now and then, the nutrient artery of the tibia bleeds profusely. Complicated fractures of the leg, of a very bad character, are also frequently produced by machinery in rapid motion, and by gunshot violence. Sometimes, again, especially when there is unusual brittleness of the osseous tissue, the bones are frightfully broken by causes so trivial as to surprise one how they could have induced such a result.

In whatever manner complicated fractures of the leg may happen, the ends of the fragments, particularly those of the tibia, are extremely liable to protrude at the wound; the latter often in such a manner as to render it very difficult to effect replacement, owing to

their being tightly girt by the edge of the opening in the integument, and also to the great length which so frequently distinguishes them. The symptoms of such accidents are always sufficiently characteristic, since there is usually not only great deformity, but likewise, as just stated, exposure of the ends of the broken pieces. Nevertheless, although no difficulty can attend the diagnosis, under such circumstances, so far as the existence of fracture is concerned, the surgeon should always institute a most careful and searching examination, with a view of ascertaining the true condition of the soft structures, the welfare of which is often much more deeply interested than that of the bones themselves. The first object, in every case of the kind, should be to determine what should be done; whether an attempt should be made to save the limb or whether it should be sacrificed. As a general rule, it may be stated that when—if I may use an antithetical and apparently contradictory expression—the complicated fracture is simple, that is, without any serious lesion of the soft parts, an effort should always be made to preserve the limb, especially if the patient is young and robust, and the bone not comminuted, although perhaps broken at several different points. It is true, such cases sometimes terminate unfavorably, both as it respects limb and life; and it should also be borne in mind that the injury sustained both by the soft and osseous tissues may be much greater and more serious than the eye and hand can possibly trace. The dangers, too, from tetanus, pyemia, erysipelas, secondary hemorrhage, and profuse and exhausting suppuration, are not to be overlooked by the surgeon in his laudable endeavors to save a patient from mutilation; nor is he to forget that such lesions, especially when seated near the ankle-joint, are extremely liable to be followed by ankylosis.

When the bones are severely comminuted, the soft parts terribly lacerated, or the ankle-joint extensively opened—in short, when the limb has been frightfully bruised, torn, and crushed—no one would hesitate to use the knife the moment sufficient reaction has taken place to enable the system to withstand the additional shock. The case even then is frequently a bad one, the patient often rapidly sinking from exhaustion, or soon after from the effects of erysipelas or pyemia.

When an attempt is made to preserve the limb, the indications obviously are to arrest hemorrhage, to coaptate the ends of the broken bone, to place the limb in an easy, comfortable, retentive apparatus, and to moderate the resulting inflammation. These intentions are best fulfilled in conformity with the principles laid down under the head of general observations on fractures. When the ends of the fragments protrude, replacement may usually be readily effected by extension and counterextension, except when they are tightly girt by the edges of the wound, when they must be liberated either with a blunt hook, or by enlarging the opening with a bistoury. When the ends are unusually long

Fig. 540.

Fracture-box.

and sharp, and disposed to protrude despite these efforts, the best plan is to retrench them with the saw or pliers, care being taken, however, not to cut off more than is absolutely necessary. Malgaigne in such cases advises the insertion of an iron screw, attached to a strap encircling the limb, into the projecting fragment, in order to place it in proper position, but of the propriety of such a procedure I entertain great doubt, as it must often be followed by erysipelas and other evil effects. The edges of the wound are accurately approximated by suture and collodion, every effort being made to exclude the air. Hemorrhage is checked in the usual manner. When the blood proceeds from the nutrient artery, and is profuse or troublesome, it may be necessary to plug the canal in which the vessel runs temporarily, with a soft piece of wood. Ample provision must be made for drainage, either by counteropening or the use of suitable tubes. Weak carbolic acid lotions and injections must be freely and frequently used, especially during the first five or six days. In short, everything must be done to maintain cleanliness and to prevent the retention of pus and blood.
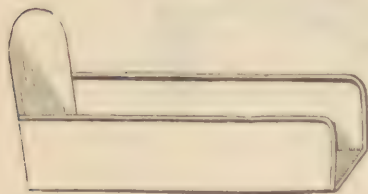
The best fracture apparatus is the wooden box, fig. 540, so much used in this city, both in private and hospital practice, consisting of four pieces, one corresponding with the back of the leg, and two with its sides, the fourth being intended for the foot. The latter, projecting nearly perpendicularly, is provided with two mortise holes, for the reception of the extending bands. The two lateral pieces are secured each by two hinges to the back board, so as to admit of being opened or shut at pleasure during the application and removal of the dressings. The limb, enveloped in the bandage of Scultetus, is care-

fully laid into the box, which is then closed, and filled with coarse bran until the whole leg and the spaces on each side of it are completely covered in. The advantage of the bran, thus used, is that it affords not only easy, equable, and comfortable support to the broken bones, but readily absorbs the discharges, and prevents the deposit of the ova of the fly, so common during the hot months of this and other countries. Substitution is effected whenever the bran becomes soiled and caked. This mode of treating compound fractures of the leg, originally suggested by the late Dr. John Rhea Barton, is unquestionably one of the most valuable improvements that have been introduced into the management of this class of injuries, whether it be viewed with reference to the comfort of the patient, the safety of the limb, or the convenience of the surgeon.

The necessary extension and counterextension are easily effected by adhesive strips. For the first week or ten days, leeches and cold water-dressing will generally be required. If suppuration arise, the most soothing application will be an emollient poultice.

The fracture-box need seldom be employed longer than eight or ten days, unless the case is an unusually bad one. By the end of this time it may generally be advantageously replaced by a McIntyre's screw splint, Fig. 541, well padded and extended, suspended in a Salter apparatus, or supported with the plaster bandage, a suitable opening being left opposite the seat of the fracture for drainage and ready dressing. In due time, the patient should be put on crutches, and sent into the open air.

Fig. 541.

Compound Fracture of the Leg, Dressed.

Complicated fractures of the leg are necessarily troublesome and tedious occurrences, requiring the utmost care and attention to prevent deformity and permanent lameness, and even then this is by no means always possible. Erysipelas, in its worst forms, often speedily follows, generally within the first forty-eight hours; copious suppuration arises, the matter, unless evacuated by timely incisions, perhaps burrowing extensively among the surrounding structures; and the system becomes rapidly undermined by hectic irritation, loss of sleep, and impaired nutrition. Great swelling, the result of a deposition of serum and lymph, frequently exists; the limb, tender and heavy, readily pits on pressure; and the joints are stiff, painful, and in danger of permanent ankylosis. The heel, unless carefully watched and protected, is sure to suffer; first, from inflammation, and afterwards, at no distant period, from ulceration, or even gangrene. Most of these local troubles may generally be prevented by the judicious use of the bandage, applied gently and equably, yet somewhat firmly, to support the capillary vessels, control muscular action, and promote the absorption of effused fluids. Passive motion should be instituted by the end of the third week, and daily repeated for many months.

Fig. 542.

Gillingham's apparatus for Ununited Fracture of the Leg.

There are no fractures in the whole body so liable to be attended with tardy union as those of the leg, or which are so frequently followed by deformity. The chief cause of these mishaps is the great difficulty which the surgeon encounters in effecting maintenance of the ends of the fragments, in consequence of their remarkable obliquity and splintered character, especially of the upper one of the tibia, which is often very thin and several inches long.

Ununited fractures of the leg are not uncommon, and may involve both bones, or be limited to one of them. In either event, the treatment is generally tedious and perplexing. In most of the cases under my observation, my main reliance has been upon the use of the perforator and the ivory peg, which have generally rendered me good service. Setons, the steel pin, and excision are inapplicable. When the patient's health is much dilapidated, and exercise in the open air is imperatively demanded, great benefit will accrue from wear-

ing the apparatus, fig. 542, devised by Mr. Gillingham, of England, and which is thus described by Mr. Holmes: "It consists of, first, a collar, which is moulded to the leg just below the knee, and on each side of which is a stud; secondly, of a boot with a socket at the heel; and, thirdly, of two steels, with ankle-joints bifid at the top to catch the studs on the collar, and capable of elongation or shortening, as seen in the engraving. Thus the weight of the body is taken off the leg-bones, and transmitted down the two side-steels." The apparatus can be equally adapted to ununited fractures of the femur.

FRACTURES OF THE PATELLA.

Fracture of the patella, figs. 543 and 544, although comparatively uncommon, derives great practical importance, from its proximity to the knee-joint, and the imperfect manner

Fig. 543.

Transverse Fracture of the Patella.

Fig. 544.
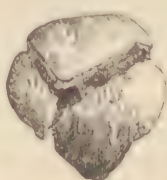
Oblique Fracture of the Patella.

in which it is usually repaired. It may extend through the bone in any direction, transversely, obliquely, or vertically, the frequency of the occurrence being in the order here stated. When the fracture is comminuted, the fissures often exhibit the most irregular arangement. Compound fracture of the patella is an uncommon, but dangerous complication.

The causes of the accident, are two, external violence, and muscular action. The transverse fracture is nearly always produced by the latter, or by the joint agency of the two, while the oblique and vertical are invariably the result of direct injury, as a fall, blow, or kick. In the latter case, consequently, there is frequently severe contusion of the soft parts, and sometimes the knee-joint is even laid open. The transverse fracture is produced by falls in which the leg is

Fig. 545.

Fracture of the Patella.

strongly flexed upon the thigh, while the body is thrown suddenly and forcibly backwards, thereby putting the extensor muscles powerfully upon the stretch, the line of fracture usually taking place just above the middle of the bone. Jumping out of a carriage and falling backwards upon the ground, is a very common way in which the accident is occasioned. Circus riders and ballet dancers sometimes break this bone in the act of leaping in the exercise of their profession.

Desault met with a case in which a man broke both of these bones simultaneously by a violent effort of the muscles to disengage the limbs from the constrained position in which they were placed during the operation of lithotomy.

Muscular fractures of this bone are very uncommon before the age of twenty-five. The greatest number occur between this period and the fifty-fifth year.

Transverse fracture of the patella is sometimes caused by direct violence, as when the bone is struck in a fall or blow, and forcibly impelled against the condyles of the femur. On the other hand, cases occur, although rarely, in which the bone is broken from within outwards, as in fracture of the articular extremity of the femur, in which one of the fragments is violently thrust against the posterior surface of the patella, perhaps shivering it into a number of pieces.

The *symptoms* of fracture of the patella are generally well marked. In the transverse form of the lesion, the nature of the accident is at once detectable by the change in the contour of the knee, by the inability to extend the limb, and by the displacement of the upper fragment, as seen in fig. 545. In many cases the person is conscious, at the moment of the injury, of something having given way, and, perhaps, he may even have heard the peculiar characteristic snap. If he attempts to get up and walk, he will be almost sure to fall, from his inability to extend the leg and support the weight of the body upon it. The displacement is usually considerable, the superior fragment being drawn upwards upon the forepart of the thigh by the extensor muscles. The height to which it may be carried varies according to the extent of the destruction of the ligamentous connection of the tendon of these muscles. When the separation is complete, it may amount to two and a half,

three, and even four inches, while, under opposite circumstances, it may not exceed six, eight, or ten lines, or be even entirely absent, the structures in front of the joint holding the fragments more or less firmly together. The distance between the two fragments is always, as a rule, considerably increased by bending the leg. The front of the knee has a flattened appearance, and upon passing the finger over it its point will be found to sink down abruptly, as it were, into the joint. The lower fragment is stationary, but the upper is easily moved, and may, by thorough extension of the limb, be brought down into its normal situation, so as to enable one to detect crepitation. If some time have elapsed since the occurrence of the accident, considerable swelling may be present, due to an effusion of synovial fluid, or this fluid and to extraärticular deposits, and more or less obscuring the diagnosis; occasionally a considerable quantity of blood is poured into the joint, especially when the fracture has been caused by external violence. The synovial burses over the patella and over the head of the tibia occasionally become greatly inflamed, and thus seriously complicate the case.

In respect to its mode of *union*, the transverse fracture of the patella holds the same relation as a similar injury of the olecranon. In both cases the nutrition of the fragments is seriously impaired by the laceration of their vessels; in both there is an inordinate quantity of synovial fluid, and in both great difficulty is experienced in maintaining coaptation. Hence, as a rule, the union is by fibrous, ligamentous, or fibro-ligamentous tissue, not by osseous. In all the examples of this fracture that I have been able to examine, both in the living subject and in museums, I have not met with any in which the consolidation was completely osseous. A few such cases, however, have been recorded by surgeons, and one well-marked specimen of the kind, found in the dissecting-room of the College, is contained in my private collection. In the inferior animals osseous union is not uncommon, if care be taken to keep the ends of the bone accurately in contact. When the interval between the broken pieces is very considerable, as, for instance, when it amounts to two inches, the union is established by the aponeurotic tissue which naturally covers the patella, and which, in this event, extends from one fragment to the other, the plastic matter which is poured out in consequence of the injury not being capable of being converted into ligamentous matter. Whatever may be the nature of the connecting medium, it is important that it should be as close and perfect as possible; for the joint will always be weak and unprotected precisely in proportion to its length and thinness.

Fig. 546.　　　　　　　　　　　　　Fig. 547.

Arterial Supply of the Patella.　　　Old Fracture of the Patella, showing the Separation of the Fragments.

It is highly probable that the very means that are generally employed to keep the ends of the fragments in contact often serve to interfere with their reunion by cutting off the supply of blood. Mr. Manning has shown by the dissection of a number of specimens that

the vascular arch of the upper fragment is situated at the precise spot where the greatest amount of pressure is usually made by the retentive apparatus; and that the lower fragment inevitably experiences a similar fate when, as not unfrequently happens, the internal, superior, and inferior articular arteries arise from a common trunk. Fig. 546 illustrates Mr. Manning's ideas.

The annexed cut, fig. 547, represents a specimen of fracture of the patella in the cabinet of the late Professor Pancoast. The bone was broken into three pieces, the superior of which was drawn up in front of the thigh, far away from the joint, and nearly four inches from the inferior, which consisted of a mere little chip, hardly two inches in width, corresponding with the lower edge of the bone. No union followed.

The fragments after this accident occasionally experience important changes in form and bulk. Now and then they undergo remarkable atrophy, but more commonly they increase in size and strength, so as to afford a broader surface for the fibro-ligamentous tissue which serves to hold them together.

The *treatment* of transverse fracture of this bone is attended with serious difficulty, on account, first, of the pressure from the accumulation of synovial fluid, and, secondly, of the difficulty experienced in controlling the action of the extensor muscles, the constant tendency of which, especially during the first six or eight days, is to draw the superior fragment upwards, away from the lower. To counteract this tendency, therefore, constitutes the chief indication of the treatment. This can be effected only by maintaining the leg steadily and faithfully in a complete state of extension, the thigh being at the same time flexed upon the pelvis, and the body kept in the semierect posture. In this manner, the extensor muscles are thoroughly and effectually relaxed. The most efficient contrivance for insuring this position of the limb is a strong, well-padded tin or wire case, long enough to reach from the middle of the thigh to the corresponding point of the leg, a roller having previously been applied from the toes upwards, and another from the groin downwards. The superior fragment, having been brought into place, is next confined by numerous adhesive strips, carried around the bone above and below the joint, and connected afterwards by vertical and transverse pieces. The dressing is completed by the application of a long, thick, and rather narrow compress, extended around the upper border of the patella, and confined by the two rollers passed around the joint in the form of the figure 8. Managed in this way, it is hardly possible for the fracture to suffer the slightest displacement, or to conceive of anything better adapted to fulfil the end in view. The tin or wire case maintains the limb in the extended position, the adhesive strips and compress retain the upper fragment in contact with the lower, and the rollers, applied in opposite directions, aid powerfully in controlling muscular action. Leeches, ice, and lotions of acetate of lead may be required when the parts are much contused or otherwise injured, and no good can result from any attempt to approximate the fragments so long as the joint is distended with synovial gland. Hence the best plan, during the first six or eight days, is to limit the treatment to the employment of rest and other antiphlogistic means, all corrective appliances being dispensed with until the immediate effects of the injury have passed off. When the quantity of effused fluid is unusually great the aspirator should be used, and the same plan may be adopted when the joint is filled, as is occasionally the case, with uncoagulated blood.

Fig. 548.
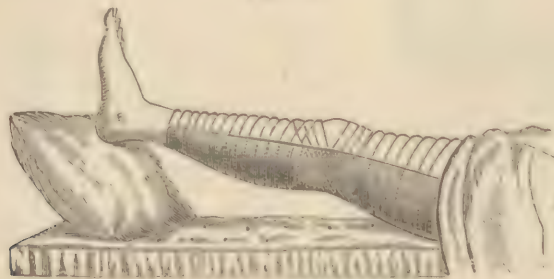
Hamilton's Apparatus.

When a suitable case cannot be procured, the object may be attained by the use of a wooden splint, well padded, and stretched along the posterior part of the thigh and leg. The adjoining drawing, fig. 548, represents the mode of dressing transverse fractures of the patella, pursued by Professor Hamilton, and also, at one time, with slight modifica-

tions, at the Pennsylvania Hospital. The plan is an excellent one, and seldom fails to effect a good cure; often with hardly any interspace between the ends of the fragments.

Mr. Erichsen, as a rule, prefers the immovable dressing, with which he has generally effected excellent cures. He applies a pad above the upper fragment and secures it with a figure-of-8 bandage, as a preliminary step. Manning's apparatus, fig. 549, which has met with much favor in England, "consists," observes Erichsen, "of a wooden back-

Fig. 549.
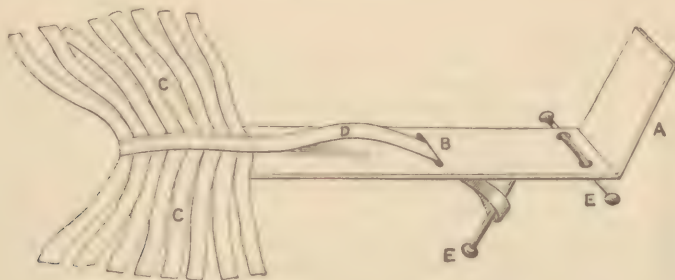
Manning's Splint for Fractured Patella.

piece, a little wider than the knee-joint, and long enough to reach from the sole of the foot to the gluteal fold, and provided at the lower end with a foot-piece, A. At the junction of the middle and lower thirds is a transverse oblique slit, B, one and a half inches long. Strips of strong plaster, two inches broad and long enough to encircle the thigh and overlap by some inches, are attached to a calico band, C. The free end of this band is carried through the slit, and the straps of plaster are open on the upper part of the splint. A piece of wood, E, is attached to the lower part of the splint, and another piece of corresponding size is attached to a loop at the end of the calico band, so that, when drawn down and the splint is adjusted, these three pieces may be five or six inches apart."

The limb having been previously bandaged from the toes up as far as the lower edge of the patella, and the splint well padded without obstructing the slit, an assistant draws down the upper fragment by grasping the extensor muscles, while the surgeon carries the plasters firmly around the thigh from above downwards, beginning immediately below the gluteal fold, and terminating about three inches from the upper border of the patella. The calico band being kept carefully in the middle line is then fastened to the splint by a few turns of a roller. "Lastly," says Erichsen, "as many elastic rings—those known as 'office bands' answer the purpose very well—as will serve to approximate the fragments without causing too much pain to the patient, are passed over the projecting ends of the pieces of wood, as at F, fig. 550, on each side of the splint, so as to exercise sufficient traction on the muscles pulling on the upper fragment."

Fig. 550.
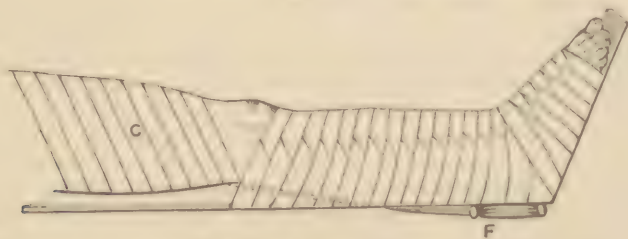
Manning's Splint applied.

Numerous contrivances are before the profession for the treatment of these injuries, nearly all constructed upon the same principles. Among the more ingenious are those of Lonsdale, Burge, Lausdale, and Boisnot. The iron ring, employed by Albucasis, De Vigo, Bassuel, Purmann, Heister, and others in the treatment of transverse fractures of the patella, was reintroduced into practice, in 1866, by Dr. W. A. Gibson, of Missouri, and in the case reported by him bony union is said to have taken place in thirty days, followed by the perfect use of the knee-joint. The ring, being well padded, is secured first to the knee by adhesive strips, and then by a roller to a light splint, two feet in length,

stretched along the posterior surface of the thigh and leg. Perhaps the very best of these contrivances is that of Wolfermann, consisting of a simple, padded steel spring, encircling the knee from behind, and ending in front in two cresecentic arms, so arranged as to embrace very closely the periphery of the patella, and kept in place by two leather straps. The apparatus, properly applied, effectually prevents flexion of the joint, and induces accurate apposition of the fragments. A splint should be stretched along the posterior surface of the limb in every case in which such a contrivance is used. Excellent results have followed this mode of treatment in the hands of Eve, Blackman, Kocher, and others.

The hooks of Malgaigne, delineated in fig. 551, were employed by that eminent surgeon in a considerable number of cases, with bony union in some, and no bad results in any; and they are now used a good deal both in this country and in Europe. The shape and construction of the instrument are perceived at a glance. Two of the hooks are inserted into the tendon of the extensor muscle, at the upper edge of the patella, and two into the lower, when they are drawn together, and kept in place by the screw. The hooks cannot penetrate the bone, much less the joint; and the only objection to them is that they may produce erysipelas. The great advantage is that they prevent the ends of the fragments from tilting up in front, thus holding them more closely and firmly together, and thereby more effectually insuring osseous union. From six to eight weeks is the period during which they should be retained.

Fig. 551.

Malgaigne's Hooks.

This treatment in this form of fracture has of late years been very fashionable at the Pennsylvania Hospital in the hands of Drs. Levis and Morton, who prefer it to every other method. Professor Agnew, on the contrary, denounces it as " diabolical." My own opinion is that it is perfectly safe when skilfully employed and carefully watched. The instrument used by Levis is composed of two separate hooks, fig. 552, an arrangement which has the advantage, as is claimed, of holding the fragments more evenly and firmly together than can be done with the original contrivance. Morton has still further modified the instrument by imparting to it, as seen in fig. 553, the form of a double triangle. That this treatment has been occasionally followed by ulceration of the joint and even the death of the patient is unquestionable, and hence it cannot be employed with too much caution. As a rule, however, I believe it to be perfectly safe.

Dr. John Rhea Barton, upwards of half a century ago, in one instance, connected the fragments together with silver wire, but lost his patient. The operation was not repeated until 1861, when it was successfully performed by the late Professor E. S. Cooper, of San Francisco, and, three years later, by Logan, of Sacramento. Dr. Hector Cameron, of Glasgow, in 1877, successfully wired the fragments under antiseptic precautions, and similar operations have now been performed in 17 additional cases, Lister having had three, and Rose and Schede each two, while single cases have been recorded by Van der Meulen, Smith, Metzler, Socin, Langenbuch, Trendelenburg, Uhdé, Bell, Holmes, and Schneider. All of the 18 cases recovered with useful limbs, except three in which the joint suppurated and became ankylosed. The operation unfortunately has not been performed sufficiently often to justify us in offering any positive opinion respecting its safety. Lister declares that it should never be employed except by practitioners who are thoroughly conversant with antiseptic surgery. I certainly should doubt the propriety of resorting to it under any other circumstances, and even then it must always be a dangerous procedure.

Volkmann connects the fragments by passing a silver wire or a strong silk ligature subcutaneously through the tendon of the extensor muscles and the ligament of the patella, and he has reported a number of cases in which he succeeded in obtaining, by this procedure, excellent osseous union. It is evidently too soon to praise or condemn this operation; but its dangers are certainly less than those attendant upon the operation which opens the knee-joint.

The injection of fresh marrow cells between the fragments, as practised by Ollier, Goujon, Wyeth, and others, has failed to secure the desired object, and scarcely deserves repetition.

Instead of raising the heel in the treatment of transverse fractures of the patella, some surgeons place the limb in the horizontal position upon a well-padded posterior splint, provided with a footboard, and extending nearly as high up as the tuberosity of the ischium, the patient observing the semierect posture as he lies in bed. The extensor muscles, it

is alleged, if not paralyzed by the accident, soon become so completely relaxed as not to exert any strain whatever upon the fragments. After the immediate effects of the injury have subsided the parts are approximated with adhesive strips, and supported with compresses and the immovable bandage. Excellent cures may no doubt be obtained by this method, but I give the elevated position a decided preference. Dupuytren declares that he treated some cases of transverse fractures of the patella successfully without the employment of any apparatus whatever, simply by keeping the limb perfectly at rest in the extended position.

Fig. 552.   Fig. 553.
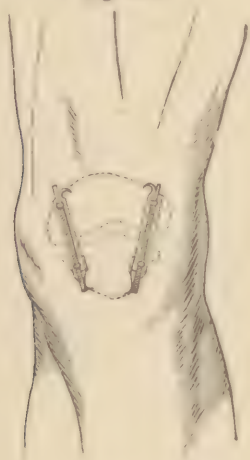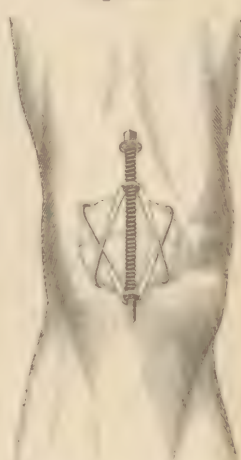
Levis's Hooks applied.   Morton's Hooks applied.

Oblique and vertical fractures of the patella generally readily unite by osseous matter, as there is but slight tendency to displacement of the fragments, owing to the fact that they are little, if at all, influenced by the action of the extensor muscles of the thigh. The prognosis is, therefore, other things being equal, always favorable, although, from the involvement of the knee-joint, a considerable period usually elapses before the patient regains the perfect use of the limb.

The signs of these oblique and vertical fractures are sometimes very obscure, especially when there is much swelling of the soft parts. In general, however, the nature of the case may be determined by the impaired motion of the knee-joint, by the fixed character of the pain, and by pressure applied to the patella in opposite directions, when, if such lesions exist, crepitation will be sure to be elicited.

The limb, having been enveloped in a bandage, should be kept at rest in an elevated and extended position until there is complete subsidence of inflammation, when the water-glass dressing should be applied, the patient being permitted to move about upon crutches. If the fracture be vertical, or nearly so, it will be necessary to support the fragments by means of two compresses, stretched along the lateral borders of the bone, and confined by adhesive strips and a roller. When the fissure is very oblique, the displacement may be such as to demand a course of treatment similar to that necessary in transverse fracture.

The stiffness of the knee-joint, which always remains after fractures of the patella, and which is often very great, no matter what mode of treatment is adopted, requires special attention, not for days or weeks, but generally for months, otherwise irremediable lameness will almost be sure to follow. Passive motion should not, as a rule, in transverse fractures, be instituted before the close of the seventh or eighth week, or until there is reason to believe that the process of reunion is sufficiently advanced to withstand the efforts. The adhesions must be broken up gradually and in the gentlest possible manner, and should be repeated, at first, every second day, and afterwards daily, until all danger of ankylosis is over. Friction with stimulating liniments, massage, and the hot and cold douches will do much in stimulating the absorbent vessels, and restoring the parts to their primitive suppleness.

A patella that has once been broken transversely is exceedingly liable to a recurrence of the accident from comparatively slight muscular contraction. The patient should, therefore, always be put upon his guard in this respect. The fracture may occur at the

same point, but generally it takes place a little higher up. Finally, when one patella has been broken, the other is apt to suffer in a similar manner, owing to the imperfect use of the affected limb, and the consequent liability of the patient to fall. Cases of this kind have occurred in my own practice, and others are referred to by Bromfield, Meuschner, Camper, Sir Astley Cooper, Malgaigne, and other high authorities.

In all fractures of this bone it is a good rule, after the first ten or twelve weeks, to protect the knee for a long time with a suitable gum-elastic cap, to rub the parts well at least once a day with some stimulating liniment, and to observe the greatest possible care in the use of the limb. The extensor muscles, especially the straight, always remain very weak after transverse fractures of the patella, and in many cases they experience a remarkable degree of atrophy, which generally lasts through the remainder of life.

Compound fractures of the patella, with penetration of the synovial membrane, are among the most dangerous of accidents, life, when an attempt is made to retain the limb, being liable to be assailed by profuse suppuration of the knee-joint, erysipelas, pyemia, pleuro-pneumonia, tetanus, and hectic irritation. For these reasons primary amputation is generally demanded. When the bone is comminuted, but the joint is not laid open, all loose fragments should at once be removed, and the case managed upon ordinary principles. In a case of this kind recently under my care, in a youth twenty years of age, owing to previous mismanagement, violent inflammation took place attended with the formation of large abscesses, and followed by necrosis, necessitating the removal of nearly the entire patella. The patient was laid up for upwards of a year, but finally made a good recovery with partial ankylosis of the knee. The great points in the treatment of such injuries are, first, to maintain the limb in an elevated position upon a posterior splint, and to keep the knee constantly covered with a bladder partially filled with pounded ice. If the symptoms are very urgent, and the patient is young and plethoric, blood should be taken freely from the arm and by leeches from the affected parts. The danger to limb and life in such accidents is generally in proportion to the amount of injury sustained by the knee-joint. Incised wounds usually do much better than lacerated and contused. Antiseptic measures should be rigidly enforced. How far they should be trusted in bad cases is an open question.

Secondary amputation may become necessary, when, an attempt having been made to save the limb, life is threatened with exhaustion by profuse suppuration and hectic irritation. Mr. Poland, who has made a special study of compound fractures of the patella, involving the knee-joint, finds, by an appeal to statistics, that such an operation, whether primary or secondary, is much less frequently called for than has generally been imagined. Of 68 cases treated without this extreme measure, only 12, or 17.65 per cent., died, while of 14 cases treated by amputation and excision, 8 perished, thus exhibiting a very great difference in favor of non-interference. In all the fatal cases, as well as in a majority of those that recovered, suppuration of the joint had occurred. Ankylosis, partial or complete, must, of course, in such an event, be a frequent sequence.

FRACTURES OF THE FEMUR.

Fractures of the femur deserve the most attentive study; for not only are they of frequent occurrence, but they present themselves under every possible variety of form, and there are no injuries of the kind which, to use the language of Pott, "so often lame the patient and disgrace the surgeon." Any portion of the bone may give way, and hence it is customary, in treating of the subject, to speak of fractures of the shaft of the femur, of its condyles, and of its superior extremity, or of its neck, and of its trochanters.

1. FRACTURES OF THE SHAFT.

The shaft of the femur may be broken in any portion of its extent, but there are three points which are particularly obnoxious to fracture. These are the upper fourth of the bone, the middle, and the inferior fourth, the relative frequency of the accident being in the order here stated, although it is generally asserted that the bone yields more frequently at or near its middle than anywhere else. This idea, however, accords neither with the results of my observations upon the living subject, nor with my examinations of specimens of fractured bones in different collections. The relative difference, however, is, no doubt, very slight. Fractures of the shaft of this bone are nearly always, in adults and elderly subjects, oblique, and, therefore, liable to be attended with great displacement, the long and sharp ends of the fragments often inflicting serious injury upon the soft parts. In

children, on the contrary, they are more frequently transverse; or, at all events, the obliquity is usually much less, and, as the muscles are less vigorous, the tendency to overlapping is not nearly so marked.

An impacted fracture of the shaft of the femur is sometimes met with, although the occurrence is very uncommon. At a meeting of the Surgical Club, of Philadelphia, in 1878, Professor Agnew exhibited the femur of a gentleman, thirty-five years of age, which had given way about its middle in the act of pulling on his boots, and in which the upper extremity of the lower fragment was partly driven into the upper a distance of upwards of two inches. Death occurred at the end of a fortnight from the effects of erysipelatous inflammation, notwithstanding which there was already a considerable amount of fibrous union.

Fractures of the Upper Fourth of the Shaft.—The most common site of fracture of this portion of the bone is from two and a half to three and a half inches below the small trochanter; the line of fracture is almost always oblique, extending from behind forwards, and from above downwards, being frequently from an inch and a half to two inches in length. A transverse fracture here is an exceedingly rare occurrence. It is also very uncommon to see the bone give way just below the small trochanter, and it is worthy of note that, when it does break at this point, it is generally complicated in its character, or associated with intracapsular fracture, properly so termed.

The symptoms of fracture seated in this portion of the femur are generally so obvious as to indicate at once the nature of the injury, the characteristic signs consisting of great shortening and angular deformity. The shortening varies from two to four inches, and usually exists in full force immediately after the receipt of the injury. The superior portion of the limb is remarkably distorted, being convex on its external surface, with a corresponding concavity internally, occasioned by the overlapping of the ends of the broken bone, the upper nearly always lying in front of the lower, being drawn in this direction by the action of the psoas and iliac muscles, and both being usually drawn somewhat outwards. In ten specimens of fracture of the upper fourth of the shaft of the femur, that I have carefully examined, I find that in all, except one, the upper fragment is in front of the lower, the reverse being the case in the other. In these ten specimens the superior piece is drawn forwards and outwards in six; in two it is tilted upwards and inwards; and in two it is raised up and in a straight line with the lower, or without any lateral deviation whatever. The distance of the fracture from the small trochanter ranges from two inches and two-thirds to three inches and a quarter.

In the six specimens in which the superior fragment is directed forwards and outwards, the lower fragment is also inclined outwards in four, the junction between them being such as to give the bone more or less of an arched appearance, the convexity being external and the concavity internal. In the two specimens in which the upper end is directed forwards and inwards, the lower end, in one, is inclined inwards also, and in the other it is straight, or in a line with the superior fragment. In seven of the eight specimens in which the displacement is lateral, the inferior fragment is more or less strongly everted, and, consequently, the knee and foot, during life, must have been in the same position.

The fractures, so far as can be determined, were all oblique, the line of disjunction, in nine, extending from behind forwards, and from above downwards, one only being in the opposite direction, and in this the lower fragment lies in front of the upper, overlapping it four inches. The distance at which the ends of the bones are separated anteriorly varies from half an inch to an inch and three-quarters. The angle which the superior fragment forms with the inferior does not, in any of the ten specimens, exceed 45°, while in most it falls considerably short of this.

I have been thus particular in giving the results of these examinations, on account of their practical bearing upon fractures of the superior extremity of the shaft of this bone. Sir Astley Cooper, and those who have adopted his views, have evidently formed very erroneous ideas, not only as regards the extent and direction of the displacement of the upper fragment, but also of its causes. Thus, it has been asserted that the upper end often overlaps the other almost at a right angle, which is not the case in any of the specimens that I have examined; on the other hand, it has been alleged that the two pieces are usually inclined outwards, which the specimens alluded to also disprove, there being no lateral deviation whatever in two, while in two others the projection was inward, leaving thus only six cases of outward displacement. The displacement forwards of the upper end is due to the joint action of the psoas and iliac muscles, assisted, perhaps, by the pectineal and the short head of the adductor, while it is dragged outwards mainly by the agency of the external rotators. The lower fragment, on the contrary, is drawn up by the action of the flexor muscles of the thigh, and outwards by the tensor, vastus, and glu-

teal muscles. That the direction of the fracture materially influences the direction of the displacement is shown by the fact that, in the only specimen out of the ten examined by me in which the line of fracture extended from before backwards, and from below upwards, the lower fragment overlapped the upper, and that to a great extent.

Although the specimens here described are, I conceive, of great pathological and practical value, it must not be forgotten that any inferences deducible from their examination are impaired, in some degree, by the fact that the displacement which characterizes them may have been influenced more or less by the nature of the treatment. Thus, in consequence of the use of splints, the ends of the fragments, originally inclined inwards or outwards, may have been pushed and held in the opposite direction, thereby completely reversing the primitive order of the deformity, as caused by the direction of the fracture, the weight of the limb, and the action of the muscles.

The annexed drawings, figs. 554, 555, and 556, two of which are from my own preparations, will serve to illustrate the nature of the displacement so often met with in fractures of the superior portion of the shaft of the femur.

Fractures at the Middle of the Shaft.—A fracture at the centre of the shaft of the femur is, according to my observation, an uncommon occurrence; most generally the bone gives way some distance above or below this point. The line of fracture is, for the most part, very oblique, extending from behind forwards and from above downwards, and the consequence is that the superior fragment nearly always overlaps the inferior, the upper extremity of which is drawn backwards, and usually, also, somewhat outwards, by the action of the flexor muscles, causing thus an amount of shortening from two and a half to three and even four inches, with more or less angularity at the site of injury, and marked eversion of the limb. The lower end of the superior fragment, on the contrary, forms a prominent projection on the forepart of the thigh, easily perceived by sight and touch. The symptoms are characteristic.

| Fig. 554. | Fig. 555. | Fig. 556. |

Fracture of the Shaft of the Femur.

A perfectly transverse fracture of the shaft of the femur is, as stated above, so extremely uncommon that, although the phenomena might be such as to lead to the suspicion of its existence, the idea that it really is an injury of that kind should not be carried out in practice, lest, the requisite extension and counterextension being omitted, permanent shortening should follow. When there is no marked tendency to displacement,

it will generally be found that the fracture, instead of being transverse, is slightly impacted, or that its extremities, being denticulated, are interlocked with each other, and thus held in place. Comminuted fracture of this portion of the shaft is not uncommon, especially in old subjects, laboring under fragility of the osseous tissue.

The accident may be the result of direct violence, as a kick from a horse or the passage of the wheel of a carriage; or it may be occasioned indirectly by a fall upon the foot or knee. In the former case it is often of a compound or complicated character. Several examples have come under my observation in which a fracture in this situation occurred in the act of pulling off the boot, the limb at the moment lying across its fellow.

Fractures of the Inferior Fourth of the Shaft.—Fracture of the inferior portion of the shaft of this bone derives a special interest from the fact that, when occurring very low down, the inferior end of the upper fragment may, particularly if very long and sharp, penetrate the joint, and thus seriously complicate a case otherwise easy of management. The fracture, moreover, is liable to be compound, the upper piece piercing the muscles and integument just above the knee. As in fracture of the other divisions of the shaft, already described, so in this the line of the solution of continuity generally ranges from behind forwards and from above downwards, a transverse fracture, properly so termed, being extremely uncommon. The degree of obliquity, although very variable, is generally so considerable as to cause great shortening of the limb and angularity of the part; which, together with the everted state of the knee and foot, are characteristic signs of the nature of the accident. The inferior fragment is always drawn backwards and upwards, its superior extremity forming a distinct prominence in the popliteal region, which may easily be effaced by restoring the pieces to their proper position. When the fracture occupies the lower extremity of the shaft, nearly on a level with the joint, the upper fragment may descend so far down as to push the patella away from the trochlea of the femur, over upon the tibia, so as to create an appearance simulative of partial luxation of this little bone. If several hours have elapsed since the receipt of the injury, the diagnosis will sometimes be obscured by tumefaction of the joint; but, in general, whatever may be the condition of the parts, any existing doubt may be cleared up by a thorough examination of the

Fig. 557.

Fracture of the Femur at its Inferior Fourth.

limb. The relative positions of the fragments in this fracture are well depicted in fig. 557, from a specimen in my cabinet.

Much swelling in and around the knee often, if not generally, attends fractures in this situation, the former being due to an effusion of synovial fluid from an extension of the irritation to the synovial membrane, and the latter to the extravasation of blood, which is frequently poured out very freely by the lacerated tissues at the seat of the injury, whence it gravitates to the capsule of the joint, but does not penetrate it. An intracapsular swelling is always readily distinguishable from an extracapsular by the fact that, in the former, the patella may be movable from side to side, and rebounds when tapped; whereas, in the latter, it remains firmly fixed.

The causes of fracture in this situation are commonly of a direct nature, a greater amount of force seeming to be necessary to produce it than when it occurs higher up. It may, however, be induced in an indirect manner, as when a person, falling from a considerable height, alights upon his foot or knee, the violence of the shock being concentrated upon the inferior portion of the femur.

Treatment.—The treatment of fractures of the shaft of the thigh-bone may be conducted according to several plans, of which that by extension and counterextension, the limb being in the straight position, is, as a rule, the most eligible, fulfilling, as it does, more effectually than any other, the different indications presented by this class of injuries. Before any steps, however, are taken to adjust the broken pieces, a suitable bed must be procured for the comfortable accommodation of the patient, as well as for the secure management of the case. This subject having been fully discussed in a previous part of the work, it will be sufficient, for my present purpose, merely to allude to it here, with the hope of enforcing more fully its importance. I am so thoroughly convinced of the utter impossibility of treating fractures of the femur successfully without a good bed, that I should consider any surgeon justifiable in declining to undertake the management of any case unless his efforts are properly seconded in this respect. There must be no compromise upon the subject; for, if the cure turn out badly, no allowance will be made by the patient and his friends for any deficiencies, shortcoming, or want of coöperation on their part. The whole blame falls upon the professional attendant, it being very properly assumed that he ought to know better than any one else what the emergency demands, and he should, therefore, spare no pains to meet it. Every fracture-bed should have slats, a good, firm but elastic mattress, and arrangements for the evacuation of the bowels, so that the patient may not be compelled to rise when he wishes to relieve himself. These essentials are all admirably combined in the ingenious and well-known contrivances of Dr. B. H. Coates, Dr. Addinell Hewson, Dr. E. Cutter, and others.

When both thighs are broken, or even when only one is affected, Jenk's fracture-bed, represented in fig. 558, will be found extremely convenient, both for evacuating the bowels and for making up the bed. It is thus described by Dr. Gibson:—

Fig. 558.
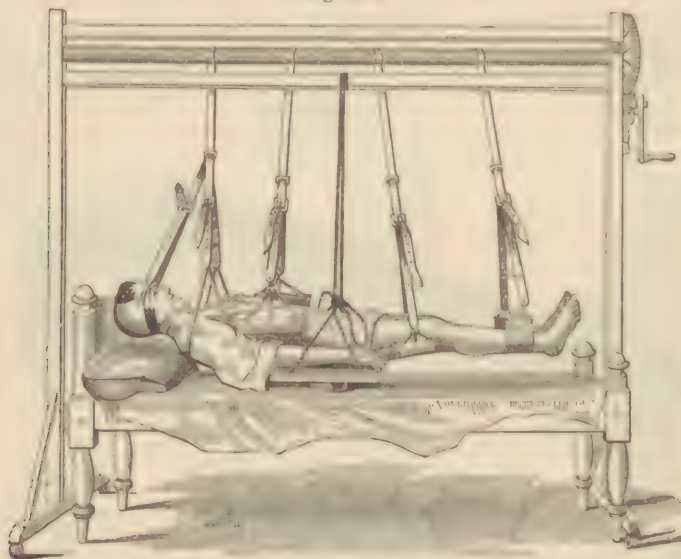
Jenk's Fracture-bed.

"It is composed of two upright posts about six feet high, supported each by a pedestal; of two horizontal bars, at the top, somewhat longer than a common bedstead; of a windlass of the same length placed six inches below the upper bar; of a cog-wheel and handle; of linen belts, from six to twelve inches wide; of straps secured at one end of the windlass, and at the other having hooks attached to corresponding eyes in the linen belts; of a headpiece made of netting; of a piece of sheet-iron twelve inches long, and hollowed out to fit and surround the thigh; of a bed-pan, box and cushion to support it, and of some other minor parts."

For the purpose of securing quietude of the limb, and accuracy of apposition of the ends of the fragments, numerous contrivances have been devised, all possessing, apparently, more or less merit, and yet not one of them being so perfect as to be wholly unexceptionable. A bare description and delineation of all the fracture apparatus now before the profession would form a stately volume. The surgical cabinets of some of our

medical schools contain cart-loads of such material, most of it as effete as the contents of a curiosity shop. Much of this apparatus has been patented, and extensively distributed by the inventors. The character of most of it is familiar to me, and I do not hesitate to declare that a large proportion of it is most villanous. The great and fundamental principles which every contrivance of the kind must necessarily possess are enjoyed by all, although in different degrees of perfection, and it cannot be doubted that the constant multiplication of such machinery, and the implicit confidence reposed in it by the younger members of the profession, are a prolific source of the many disastrous results which so frequently attend the treatment of fractures of the thigh. I have long been satisfied that the more simple the apparatus is, the more easily it is managed, and the more likely to prove efficient. With a proper knowledge of what is needed, and a little ingenuity on the part of the surgeon, the requisite means for the successful management of almost every case of fracture of the femur, however bad, may generally be provided either upon the spur of the occasion, or within a reasonable time after the occurrence of the injury. The plaster splint now coming into general use is one of the best of the many modern contrivances.

The apparatus at one time so extensively employed in this country was that of Desault, as modified and improved by Physick, consisting of one long splint, fig. 559, extending from below the sole of the foot to the axilla, and of a short one extending from the same point to the perineum. They are connected below by a transverse bar, for receiving the extending bands, and along the leg and thigh by strips of bandage. The counterextension is effected by a suitable thigh belt, the ends of which are passed through the mortise holes near the upper end of the splint. The apparatus is, however, an awkward one, constantly subject to derangement, and the results obtained by its aid are by no means so gratifying as they should be. It has always been found extremely unsatisfactory in my practice, and I have, therefore, for many years, never employed it in a single case, having given the preference to the fracture-box, represented in fig. 560. This box, which I used, for the first time, upwards of

Fig. 559.

Physick's long Splint.

Fig. 560.
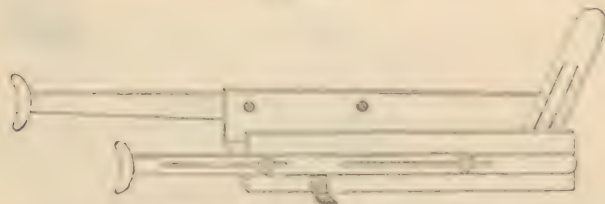
Fracture-box with Side Splints.

forty years ago, extends from the tuberosity of the ischium to a level with the sole of the foot, which rests against the vertical piece, provided with two slit-like holes for the passage of the extending bands. The posterior surface of the box is hollowed out for the more easy accommodation of the thigh and leg, while the side pieces, fastened by hinges to the horizontal one, project so as to come to a level with the surface of the limb in front. To the outside of the box is secured a movable splint, about two inches in width, crutch-shaped and well padded above, and long enough to reach into the axilla, while another similarly arranged and constructed, is attached to the inside, being intended to press against the perineum. The whole apparatus is made as light as possible, and any intervals that may exist between it and the limb, after it has been properly adjusted, may be filled with cotton, tow, or, what is preferable, especially in compound fractures, wheat bran, the latter answering an admirable purpose, under such circumstances, not only affording an agreeable protection to the broken bone, but absorbing the discharges and preventing the development of maggots, which are so liable to form in such cases in hot weather. In changing the dressings, all that is necessary is to let down the sides of the box, the extension being, in the mean time, kept up, if necessary, by an assistant having hold of the foot. A broad leather splint, or one of binder's board, extending from the groin to the knee, should cover the thigh in front; it should be accurately moulded to the parts, and be firmly secured in its place with pieces of tape encircling the box.

Instead of the fracture-box now described, use may be made of two splints, one of binder's board and the other of wood, the former, which is intended for the inside of the thigh, reaching from the groin to the knee, while the other, placed along the outside of the limb, extends as high up, on the one hand, as the crest of the ilium, and, on the other, as low down as four inches below the level of the sole of the foot. These splints being well padded, are secured with an ordinary roller, the adhesive strips being attached to the inferior extremity of the long one, in order to keep up the requisite degree of extension.

Adhesive plaster is now universally employed in this country, both for maintaining extension and counterextension in fractures of the thigh, and is unquestionably a great improvement upon the means heretofore in use, as it tends not only to preserve the ends of the fragments in better and closer union, but, what is of great moment to the patient, prevents the pain, chafing, and ulceration which so frequently attended the old methods. The treatment is equally serviceable in simple and in compound oblique fractures of the lower extremity.

In a remarkable case of compound fracture of both thigh-bones, in a boy eleven years of age, under the care of the late Dr. Gilbert, an excellent cure was effected by the appa-

Fig. 561.

Gilbert's Fracture Apparatus.

ratus represented in fig. 561, aided by adhesive plaster. A long splint was stretched along the outside of each limb, from a few inches below the sole of the foot to within a short distance of the axilla; the extending strips, tied under the sole of the foot, and secured to a horizontal block, were controlled by a tourniquet; while the counterextending strips were carried along the pelvis, both in front and behind, and firmly fastened by transverse bands passed around the hip-bones, the back, and abdomen. The dressing was removed on the forty-fifth day.

Fig. 562.

Hodge's Method of Counterextension in Fracture of the Femur.

A valuable addition to the long splint, affording increased means for making counterextension, was suggested by the late Dr. H. Lenox Hodge. It consists, as will be seen by reference to fig. 562, of a bar of wrought iron, secured to the outer and upper part of the splint by bolts with movable nuts, and bent to the right or left, in accordance with the side to which it is applied. The splint should be sufficiently wide above to permit the rod, which terminates in a horizontal hook, about six inches in length, to pass clear of the patient's arm and shoulder. A long strip of adhesive plaster, at least two inches and a half in breadth, is extended along the front of the body from the pelvis to the top of the shoulder, and thence down the back to the buttock, leaving, as it crosses the shoulder, a short loop, in which is placed a small block of wood, fastened by means of a tape to the hook of the bar. To prevent the long strip from becoming detached, the body is completely encircled, at different heights, by three horizontal bands.

The advantages of this contrivance are that the extension and counterextension are made in a straight line, that the dressings maintain their place much longer than the ordinary ones, and, lastly, as the patient cannot sit up in bed, there is less danger of dis-

placement of the ends of the broken bone. To impart efficiency to the apparatus a foot-board should be added.

The *anterior splint*, as it is called, invented by the late Professor N. R. Smith, often yields excellent results in the treatment of fractures of the thigh, especially in the more complicated ones. It consists, as seen in fig. 563, of a single piece, made of wire, of the

Fig. 563.
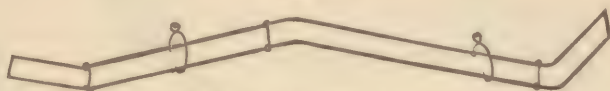
N. R. Smith's Anterior Splint.

size of a No. 10 bougie, and bent at each extremity, the whole representing the form of a long parallelogram, three inches wide above, and two inches and three-quarters below. It must be long enough to reach from a point a little above the anterior spinous process of the ilium to an inch beyond the toes, when the thigh, leg, and foot are extended, three feet eight inches being a good average length for adults. The side-pieces are firmly connected by cross-pieces at a distance of about eight inches from each other. Thus constructed, the wire frame is easily bent to suit the case in hand. The angle at the tibio-tarsal joint, six inches from the extremity, is about 120°, to secure an easy posture for the foot; that at the knee and the one at the hip are each about 160°, the latter being seven inches from the upper extremity.

The splint, properly padded or tightly wrapped with a muslin bandage, and secured to the limb by a roller extended from the toes upward, is suspended by means of a pulley, cord, and hooks to the ceiling, as represented in fig. 564, a compress being placed upon

Fig. 564.

N. R. Smith's Apparatus applied to the Limb.

the instep and another upon the groin, to ward off pressure. The proper position of the hooks is a matter of great consequence. In general, the upper one should be attached nearly over the seat of the fracture, and the lower a little above the middle of the leg, the object being the thorough equalization of the pressure of the splint. The roller, con-fining the apparatus, should be well stitched to prevent it from slipping, or, what is better, wet, with a solution of silicate of sodium, and great care should be taken that it do not make undue constriction. This apparatus, which is exceedingly light and comfortable, is equally well adapted to fractures of the thigh and leg, in every portion of their extent.

The late Professor Hodgen, of St. Louis, used with great success a wire suspension splint, the bars of which are traversed by cotton sacking for the more easy and equable sup-port of the limb. The apparatus, depicted in fig. 565, is particularly adapted to the treat-ment of compound fractures of the lower extremity.

The mode of treating fractures of the thigh, originally suggested by Dr. Gurdon Buck, is now generally pursued in this country in most cases in which confinement in bed is necessary, and every surgeon of experience can bear testimony to its great excellence.

The long splints are entirely dispensed with, the extension being made by the action of a weight and pulley, and counterextension by the usual perineal strap lengthened out and fastened to the head of the bedstead. A strip of adhesive plaster, from two and a half to three inches in width, is stretched along each side of the limb, to a short distance above

Fig. 565.
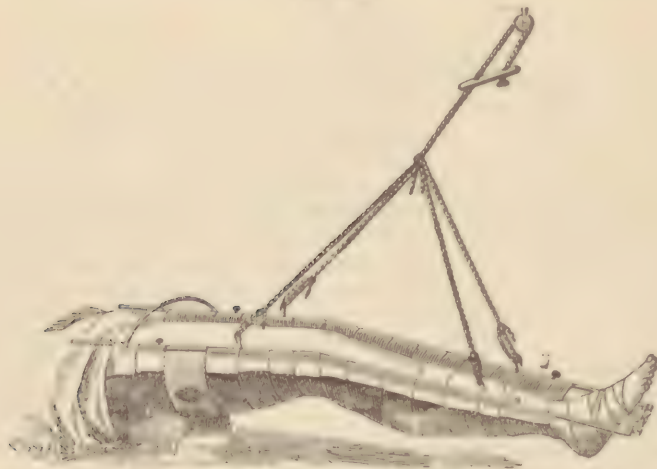
Hodgen's Suspension Apparatus.

the knee, and confined with a roller extended from the toes up, the middle of it forming a loop below the sole of the foot. A thin block of wood, the width of the plaster, and long enough to prevent pressure over the ankle, is inserted into the loop, and thus serves

Fig. 566.
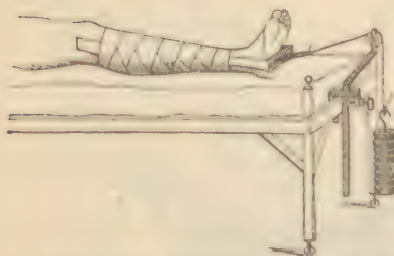
Levis's Extending Apparatus with Pulley and Weights.

to receive the extending cord, which is fastened to an elastic rubber band passing around the block, and playing either over the footboard of the bedstead, or, if there is no footboard, over a temporary frame, perforated at a height of about five inches above the level of the mattress, or, what is better, an adjustable clamp, holding in position the rod which supports the pulley, as seen in fig. 566. The thigh, at the seat of fracture, is surrounded with short splints, the heel is supported upon a thin, wedged-shaped hair cushion, and a bag, filled with sand, is placed along the outside of the leg and foot to prevent rotation. The amount of weight employed must be determined by the age of the patient and the other circumstances of the case. A child under eight years of age will seldom require more than five or six pounds, while an adult may require from fifteen to twenty, the substance being shot, iron, or sand. The most suitable perineal band is a piece of India-rubber tubing of one inch caliber, two feet in length, with a ring at each end, stuffed with bran or cotton lampwick, and covered with canton flannel, wrapped spirally round it, and renewed whenever it becomes soiled. The apparatus of Dr. Buck is represented in fig. 567.

The treatment of fractures of the thigh, introduced by Dr. Swinburne, recommends itself by its simplicity and efficiency. It consists, as will be seen by a reference to the annexed sketch, fig. 568, exclusively of extension and counterextension, without splints, the perineal and crural bands being secured to the bedstead, as in Dr. Buck's apparatus, and composed of similar materials. Free use is made of adhesive strips at the leg and foot, and also, if necessary, at the thigh. With such an arrangement the affected limb may be inspected or measured as often as may be desired, all danger of embarrassing the circulation is done away with, perfect cleanliness may be preserved, and any topical applications that may be required may be made and removed with the utmost facility. The advantages of this method are particularly conspicuous in complicated fractures of the thigh. Fractures of the femur and tibia treated in this manner leave very little, if any, shortening, except in the intracapsular form of the accident.

In addition to the contrivances here described and delineated for the treatment of fractures of the lower extremity, numerous others have been devised, some of which are suffi-

Fig. 567.
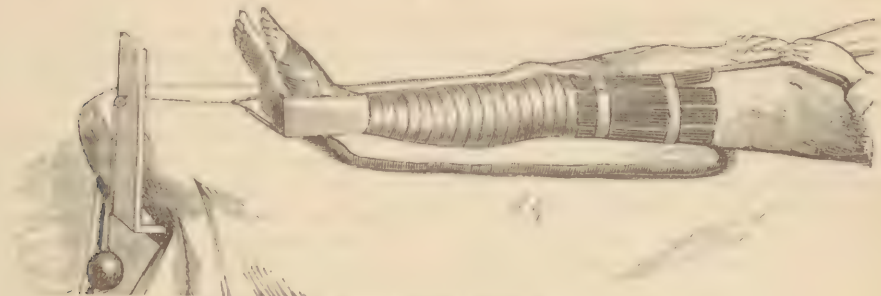
Buck's Fracture Apparatus.

ciently meritorious as to be worthy of special notice. Among these, two of the most valuable are those of Dr. Richard J. Levis and Dr. Thomas G. Morton. The subjoined drawings are so graphic as to render any description needless. Fig. 566 illustrates the apparatus of Levis. The pulley is secured by its shaft to the end of the bed, and receives

Fig. 568.
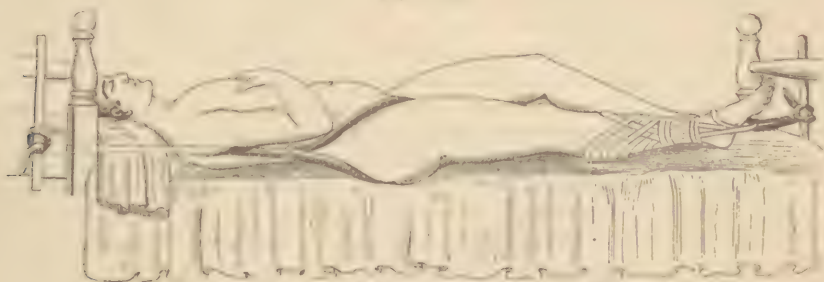
Swinburne's Method of treating Fractures of the Thigh.

the cord which is attached to the patient's limb. The weight consists of a number of perforated pieces, and is secured to the extending cord by means of a hook. Morton's apparatus, fig. 569, so extensively used at the Pennsylvania Hospital, is also very simple,

Fig. 569.
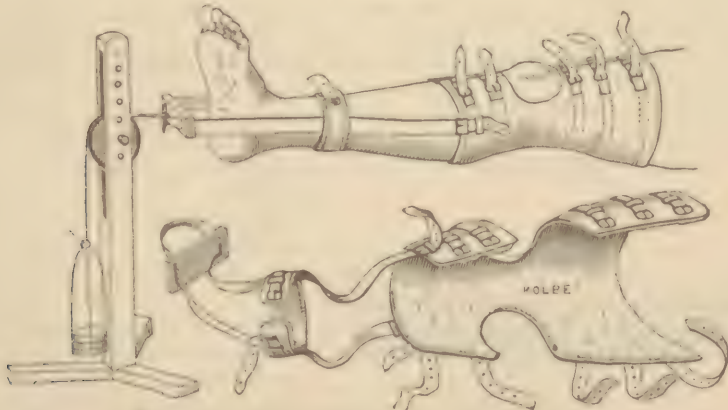
Morton's Extending apparatus for Fracture of the Femur.

and, like that of Levis, fulfils every indication for which such a contrivance can be employed.

Finally, counterextension may advantageously be made by elevating the foot of the

bedstead, so as to allow the patient's body to sink into the upper part of the bed, and thus, by its weight, draw the superior fragment away from the inferior. This mode of treatment, in which a perineal strap is rendered unnecessary, was extensively practised during our late war, and its efficiency is undeniable, as every experienced surgeon can testify from personal observation.

Whatever apparatus be employed, whether those now described, or others of a similar character, there are several circumstances which should claim the special attention of the practitioner, particularly in the treatment of fractures of the shaft of the femur. The kind of bed to be used is described under the head of general treatment.

1. The ends of the broken bone must be steadily maintained on a line with each other, any tendency to angularity, lateral distortion, or tilting up of the fragments being promptly counteracted by pressure opposite the point of projection. This disposition manifests itself, more or less, in nearly all fractures of the femur, and should never for a moment be lost sight of, otherwise it may not be discovered until it is too late to remedy it. It is particularly strong when the lesion is situated from two and a half to three inches below the small trochanter, in consequence of the action, on the one hand, of the iliac and psoas muscles, and, on the other, of the external rotators ; the former, as before stated, tilting the lower end of the superior fragment forwards, and the latter outwards. For want of attention to this circumstance, wretched deformity of the limb is a frequent result of this injury.

2. No shortening must be permitted, and, therefore, constant vigilance must be exercised in regard to the tightening of the extending and counterextending bands. If any doubt exists, a comparative estimate must be made from time to time of the length of the two limbs, by stretching a piece of tape from the centre of the umbilicus to the centre of the inner border of each patella, or from the anterior superior spinous process of the ilium to the internal malleolus, the body and limbs lying perfectly straight.

3. A slightly everted position of the limb being the most natural when the body is dorsally recumbent, the surgeon should aim to maintain it in that way during the period necessary for the reunion of the ends of the broken bone.

4. The heel must be seen to ; if neglected, it will be sure to inflame and ulcerate, if not slough. Too much care, therefore, cannot be taken to ward off pressure by filling up the hollow on each side of the tendo Achillis with cotton, or by employing, if necessary, a small air-bag, or a bladder partially filled with water. The foot should always be well supported.

5. Extension must be maintained with two broad strips of adhesive plaster, stretched along the sides of the leg, previously shaved, to three inches above the knee, secured by cross-pieces, and fastened to the foot-board of the splints or fracture-box. Or, instead of this, two long, broad strips of muslin are secured to the limb by means of a roller, the upper extremity of each being turned, loop-like, down upon itself, over the bandage, and then properly fastened. The gaiter and handkerchief should be discarded from practice, for reasons previously mentioned.

6. The perineal band must receive due attention, otherwise it will be sure to gall and fret the parts, and thus greatly distress the patient. Besides, if not properly managed, it will be extremely liable to displace the upper fragment, by dragging it outwards, away from the inferior.

7. In compound fractures, one of the splints may be bracketed, as originally recommended, in 1813, by Dr. Hayes, of Indiana. The opening thus left permits ready access to the wound, and, consequently, great convenience for the application of the necessary dressing. The annexed cut, fig. 570, affords an illustration of an excellent apparatus of this kind, devised by Dr. John H. Packard, of this city.
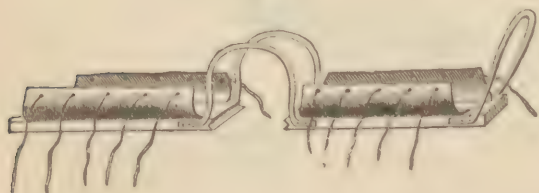
Fig. 570.

Packard's Fracture Apparatus.

8. Great objection has been urged by certain writers against the employment of the bandage in the treatment of fractures of the thigh, on the ground that it is not only inconvenient, but absolutely useless. My experience does not corroborate this statement. On the contrary, I have always derived the most marked advantage from the bandage, both in controlling spasm, in counteracting the tendency to shortening, so common in nearly all cases of this kind, and in

promoting the absorption of inflammatory deposits. To answer the purpose, however, it must be applied with great care; otherwise harm, not benefit, will result.

In simple fractures of the thigh, the ordinary roller is sufficient; but in compound, preference is given to the bandage of Scultetus, inasmuch as, being composed of separate strips, it admits of more easy removal and reapplication.

The water-glass, starch, gum, or plaster bandage, may often be employed with great advantage, giving adequate support to the broken limb, and enabling the patient to take exercise in the open air, or about the house, upon crutches, a matter frequently of great importance. My experience, however, is averse to its use in the early stage of the treatment; applied too soon after the accident, before there is complete or nearly complete subsidence of inflammation and swelling, it may do incalculable harm, not only materially aggravating the local trouble, but endangering the safety of the limb by the induction of gangrene. For these reasons I seldom employ it before the end of a fortnight. In hospital practice, where the patient is under the constant surveillance of the professional attendant, the permanent dressing may generally be employed much sooner.

9. The bedclothes must be kept off the fractured limb, as their weight would not only be oppressive, but tend to derange the ends of the fragments. A good and ready mode of accomplishing this is to cut a stout barrel-hoop through at the middle, and to place the two halves, tied firmly together, crosswise, over the injured extremity. Or, instead of this contrivance, the surgeon may use, what is much better, the frame depicted at page 912.

10. It is very important, in the treatment of fractures of the lower extremity requiring extension and counterextension, that the patient's head and shoulders should not be raised high; a small pillow is generally quite sufficient, and, in some cases, even this may very properly be dispensed with.

11. Mr. Pott conceived the idea that the best mode of treating fractures of the femur was to place the affected limb upon its outside, the body inclining in the same direction, and the knee being in a semiflexed state. The leg and foot, supported upon smooth pillows, were elevated somewhat above the level of the thigh, which was enveloped by a many-tailed bandage, and covered in by two broad, carved wooden splints. This plan, which Mr. Pott recommended with all the enthusiasm of a man of genius, was based upon the erroneous notion that it would completely relax the different sets of muscles connected with the broken bone, thus preventing them from acting injuriously upon its fragments; forgetting that, in proportion as he took off the tension from one class, he necessarily increased that of another. It has been found to be altogether impossible to carry out this plan successfully in practice, experience having shown that the patient is utterly unable to remain so long in one position without suffering greatly from bed-sores, and that the apparatus, with all the care that can be taken to keep it in its place, is wholly inadequate to answer the purpose of an accurate adjuster.

12. Another mode of treating fractures of the body of the femur, very different from any hitherto described, was formerly much in vogue both in England and in this country, chiefly in consequence of the influence of the late Sir Charles Bell, by whom it was extensively employed for a long time at the Middlesex Hospital, London. It consists in placing the limb upon two grooved cushions, resting upon two pieces of board, united by hinges in the form of a double inclined plane, as seen in fig. 571, and long enough to

Fig. 571.
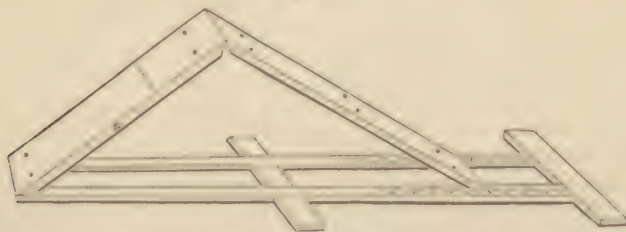
Double Inclined Plane of Sir Charles Bell.

extend from the tuberosity of the ischium to the back part of the heel. A roller having previously been applied from the toes to the groin, two light but firm binder's board splints, carefully softened in hot water, are secured to the outer and inner parts of the thigh, meeting nearly in front and reaching from the groin to the knee. The extremity

is now laid over the inclined plane, in an easy, comfortable position, the angle of flexion having special reference to this point ; the foot is attached to the foot-board, and the limb and plane being tied firmly together by tapes, or, what is better, by a bandage, the dressing is completed.

The method of treatment by the double inclined plane ought not to be too lightly condemned, for it cannot be denied that very excellent cures are occasionally effected with it. Much less frequently employed now than formerly, it is more particularly applicable to the treatment of fractures of the condyles of the femur and of the upper extremity of this bone, attended with a constant disposition to displacement of the lower end of the superior fragment. In transverse fractures immediately above the knee-joint, and in separation of the inferior epiphysis of the femur, the gastrocnemial muscles drag the lower fragment backwards into the popliteal space ; an effect which can only be counteracted by the flexed position of the limb, the leg, in the more troublesome cases, being bent almost at a right angle with the thigh. The double inclined plane may also be advantageously employed in compound fractures, attended with severe contusion and laceration of the integument, where confinement in the extended position would be productive of violent pain and great discomfort. The extension is made mainly by the weight of the leg and foot, while the counterextension is made by the pressure of the apparatus against the tuberosity of the ischium. The annexed drawing, fig. 572, represents McIntyre's splint, a double inclined plane, modified by Liston. Fig. 573 exhibits it as it is applied to the limb.

Fig. 572.

McIntyre's Splint, simplified and improved by Liston.

Fig. 573.

McIntyre's Splint applied to the Limb.

Finally, when both thighs are broken, the case may be treated with a double inclined plane, or a fracture-bed, the hinges being arranged in such a manner as to permit the trunk to be raised or lowered at pleasure, without causing any motion of the hips. The limbs should be well protected with side and front splints, and immovably tied together.

13. The period required for the consolidation of fractures of the shaft of the femur must necessarily be greatly influenced by circumstances, as the age and health of the patient, and the care with which the ends of the fragments are kept together. In children from five to fifteen years, complete union may usually be looked for in from twenty-four to twenty-eight days. In eighteen cases analyzed by Dr. A. L. Peirson, of Massachusetts, the cure, in persons of thirty years of age and under, occupied 35.88 days ; while in seventeen, where the age was upwards of thirty, the average period was 36.64 days ; thus showing only a very trifling difference in the two series. On no account should any weight be thrown on the affected limb under ten or twelve weeks. From a want of this precaution great shortening often results, especially in those cases in which the new osseous matter is slow in acquiring its proper density and firmness.

It has been asserted by many highly respectable practitioners that it is always extremely difficult, if not impossible, to effect a cure in fractures of the shaft of the thigh-bone without some degree of shortening, and my conviction is that this conclusion is only too well founded. There can be no question at all that in many cases a certain degree of shortening is absolutely and positively unavoidable, not on account of any defect in the treatment, but from the very nature of the fracture itself. How is it possible it

should be otherwise, when the ends of the fragments are driven the one into the other? The best skill and the most devoted attention would utterly fail, under such circumstances, to make a good limb. So, also, when a fracture is compound or comminuted, more or less deformity and shortening will almost be inevitable. In the New York Hospital, where fractures of the shaft of the thigh-bone are very common, and where this accident is probably treated with as much adroitness and care as anywhere in the world, from a third to half an inch of shortening is generally looked for, as a natural consequence, by the surgeons of that Institution, and it is questionable whether the statistics of similar establishments, if ascertainable, would exhibit a more favorable result.

In 149 cases of fractures of the thigh, reported by Dr. Buck, as having been treated according to the method which bears his name, the average shortening in patients under fifteen years of age was ⅜ of an inch, and ⅝ in those over fifteen years. In some of the cases there was no shortening whatever.

Professor Hamilton finds, as the result of his investigations, that the average shortening in simple fractures of the upper third of the femur is about four-fifths of an inch, and of the remainder of the bone, stated in round terms, three-quarters of an inch. He adds that, in oblique fractures of the shaft of the femur, in which the muscles retain their contractile power, no apparatus that has yet been devised can entirely prevent shortening; and the same, he remarks, is true of transverse, oblique, and denticulated fractures, in which the ends of the fragments have become completely deranged, owing to the impossibility of placing them in such relations as that they will rest upon and support each other during the time necessary for reunion. He further states that in children, and in persons under eighteen years of age, the cure is frequently so perfect as to render it impossible to discover any material shortening by measurement of the limb.

2. FRACTURES OF THE INFERIOR EXTREMITY.

Fracture of the condyles of the femur is, in comparison with fracture of the condyles of the humerus, an extremely infrequent occurrence. Indeed, it is very uncommon, not only relatively, but absolutely, speaking. Sir Astley Cooper mentions only two instances of the kind in his work on Dislocations and Fractures; the Dupuytren Museum at Paris, so rich in osteological preparations, contains but five specimens of the lesion; and in the Mütter collection, not a single bone, illustrative of the occurrence, is to be seen. The cabinet of Professor William Gibson, now in the Government collection at Washington City, has, however, several beautiful specimens of fracture of the condyles; and among my own preparations is a very rare one, in which these eminences are broken off vertically, leaving the trochlea attached to the lower end of the shaft, which exhibits a remarkably comminuted appearance, consisting of not less than five distinct fragments.

The fracture may be limited to one of the condyles, which, however, is extremely rare, or it may implicate both, the fissure in the latter case extending between the two prominences, and terminating above in an oblique fracture of the shaft, so as to give rise to three distinct fragments. From the amount of force required to produce this fracture, it is generally attended with a great deal of injury to the soft parts, and, for the same reason it is not unfrequently of a compound and comminuted character, the ends of the fragments protruding either externally or projecting into the cavity of the knee-joint. A partial fracture of one of the condyles occasionally occurs. In rare cases, the fracture presents the character of impaction, the lower end of the shaft being forcibly impelled into the cancellous structure of the condyles, which are completely severed in their entire length. Fig. 574 conveys an excellent idea of a fracture of the external condyle from a drawing of Sir Astley Cooper.

Whatever form the fracture may assume, it is nearly always the result of direct violence; generally of a fall upon the knee, the passage of the wheel of a carriage, or the kick of a horse. In one of three cases that have been under my observation, it was occasioned by a fall from a high scaffold, the individual, a man upwards of fifty years of age, alighting upon his feet, but striking, before he could recover himself, his knee against a large stone. The subjects of these fractures are usually old persons, in whom the condyles of the femur have become atrophied and brittle from the effects of interstitial absorption and fatty degeneration.

Fig. 574.
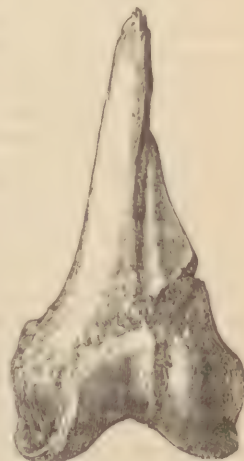
Fracture of the External Condyle.

The *symptoms* of fracture of the condyles are not always well characterized, owing to the fact that the fragments are generally held in place by the ligaments of the knee, thus preventing marked deformity, and rendering the production of crepitation difficult. The joint appears to be wider and flatter in front than usual, and, if the patella be pressed backwards, the condyles may be considerably separated, so as to increase the transverse diameter of the limb. The joint is much swollen and bruised, the member is completely powerless, and, when the fracture affects both prominences, there is nearly always marked shortening, often amounting to from one to two inches, the lower fragment being drawn up behind the superior by the action of the hamstring muscles. When only one condyle is broken, the deformity, other things being equal, will be less than when both suffer, and there will also, of course, be less shortening. Blood, often in considerable quantity, is generally poured into the joint in injuries of this kind, and more or less synovitis is an inevitable consequence.

In the specimen of vertical fracture of the condyles in my cabinet, previously alluded to, the short fragment is drawn upwards against the posterior surface of the shaft of the femur, to a distance of at least two inches, its upper surface looking towards the trochlea, with which it forms an obtuse angle, thus greatly increasing the antero-posterior diameter of the joint. The various appearances of this rare specimen are well represented in fig. 575.

Fig. 575.
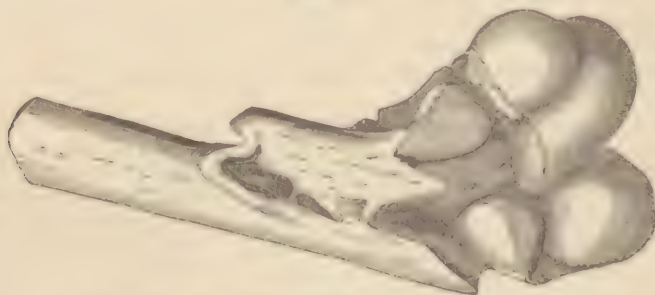
Comminuted Fracture of the Lower Extremity of the Femur.

Fracture of both condyles occasionally simulates partial luxation of the head of the tibia backwards; and, when this is the case, the only way to determine the diagnosis is to take hold of the condyles, and to press them in opposite directions, which cannot be done when there is no fracture. The same proceeding can hardly fail to elicit crepitation, although this may be rather slight, especially if the fragments are held firmly together by the ligaments.

The prognosis of this fracture is especially grave, on account both of the injury done to the soft parts, and of its connection with the joint, which may be involved in an alarming degree. The fracture may, as already stated, be compound or comminuted, and, in such an event, the danger will, of course, be greatly increased, perhaps to such an extent as to require amputation, or, when this is not deemed advisable, in such a manner as to jeopard life by mortification, pyemia, erysipelas, or congestive pneumonia.

The *treatment*, in the first instance, must usually be strictly antiphlogistic, leeches and evaporating lotions being necessary, on account of the injury done to the soft parts. The limb, enveloped in a bandage, is laid in an easy position, being extended, if the fracture be transverse, or nearly so, and placed over a double inclined plane, if it be very oblique, with a strong tendency to displacement of the broken ends. Spasm, so common after such accidents, is allayed by anodynes, and an effort is made to prevent erysipelas and other bad consequences. When the tendency to displacement is uncontrollable by ordinary means, the best plan is to divide the tendo Achillis in order to counteract the action of the gastrocnemius muscle. Passive motion is instituted at the expiration of five or six weeks, but, despite the attention of the surgeon, a good, unexceptionable cure will be extremely difficult, if not impossible, especially when both condyles are implicated.

Complicated fractures of the condyles are generally the result of direct violence, as the passage of the wheel of a carriage, a fall from a great height, or gunshot injury, and are among the most dangerous of accidents, bringing life in jeopardy by tetanus, erysipelas, pyemia, profuse suppuration, and hectic irritation. The danger is proportionately increased when the lesion is attended with an extensive wound of the knee-joint, or a comminuted

condition of the bone. An attempt may be made to preserve the limb when the patient is young and in good health at the time of the fracture, when the weather is not too hot and exhausting, and when the injury in the soft parts is comparatively slight; under opposite circumstances the best plan, as a rule, will be to amputate immediately after the occurrence of reaction. To hesitate, in such a case, would only be to trifle with the patient's life, which could hardly fail to be the forfeit of the surgeon's timidity.

Examples of diastasis of the inferior *epiphysis* of the femur are occasionally met with. In a case observed by Coural, the accident happened in the act of falling forward at a moment when the leg was buried up to the knee in a hole.

Fig. 576.

The shaft of the femur was driven behind the condyles into the popliteal space, and there was such an amount of injury as to necessitate amputation of the limb. The patient was a boy, eleven years of age. Little, Voss, and Buck have reported similar instances. I have met with this accident not less than four times in attempts at breaking up the adhesions in ankylosed knees, and have never found any difficulty in effecting good and prompt cures by putting up the limb at once in appropriate apparatus. In most of the cases hitherto reported the accident was the result of such severe violence as to necessitate amputation. The injury has generally been of the nature of compound fracture, attended with extensive laceration of the soft parts. In one case the anterior tibial artery was torn open, and in another, related by Dr. Willis S. Davison, of Pennsylvania, the popliteal vessels were ruptured: in a few instances the knee-joint was exposed. In all such cases the prognosis must needs be unfavorable. When the injury is uncommonly severe, or the condyles are comminuted, great deformity may result, or shortening of the limb may take place from an arrest of development of the femur. The epiphyseal fracture is well illustrated in fig. 576, from Holmes. Such occurrences are, for obvious reasons, peculiar to young subjects before the twentieth year. Madame Lach-

Separation of the lower Epiphysis of the Femur combined with Fracture.

apelle saw a case of diastasis of the inferior epiphysis of the thigh-bone from traction on the child's foot during parturition. The lesion was conjoined with a separation of the upper epiphysis of the tibia.

3. FRACTURES OF THE SUPERIOR EXTREMITY OF THE FEMUR.

The superior extremity of the femur comprises the head and neck of that bone, together with the two trochanters, so that in an individual of ordinary stature it is from three inches and a quarter to three inches and a half in length, there being, however, no distinct boundary line between it and the shaft. The head composes nearly two-thirds of a sphere, and rests upon the neck, which is inclined obliquely upwards and inwards, so as to form an obtuse angle with it; they are surrounded by the capsular ligament, the strongest membrane of the kind in the body, and consist of a large amount of spongy tissue, inclosed by a thin lamella of compact substance. Both these structures undergo important changes with advancing age, the former becoming greatly rarefied, light, and porous, while the latter is so attenuated as to be, in some places, hardly as thick as common letter paper. These changes, the necessary effect of which is to render the bony texture frail and brittle, are particularly conspicuous after the fiftieth year, and readily explain the frequency of fracture of the neck of the femur at and after this period of life. There is another circumstance, also, which, doubtless, materially contributes to this accident, namely, the alteration which this portion of the femur undergoes in its direction in old persons, causing it, in many cases, to stand off almost at a right angle with the shaft of the bone, or even to sink slightly below this level. This alteration in the obliquity of the bone is, generally, more common, as well as more marked, in women than in men, and hence it is that the former are always more liable to this fracture than the latter. These various appearances are well illustrated in the adjoining sketches, fig. 577 representing the ordinary normal shape of the head and neck, together with its spongy and compact structures, while fig. 578, from a preparation in my collection, affords a good idea of the changes which these parts experience in consequence of the effects of age.

The ligaments of the hip-joint always sustain very grave injury in fracture of the superior extremity of the femur. When the lesion occurs within the articulation, the capsule is always torn across, the rent being frequently so large as to permit the escape of the upper extremity of the lower fragment, either at the moment of the accident, or

Fig. 577.

Fig. 578.
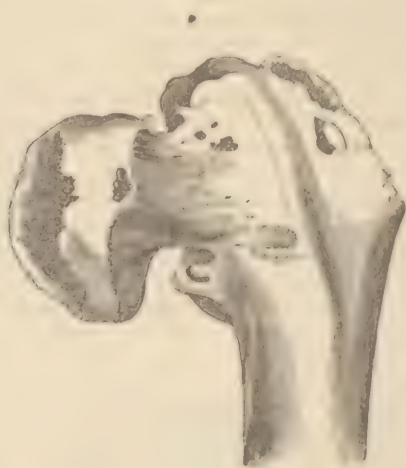
Natural Appearances of the Head and Neck of the Femur.

Alterations of the Head and Neck of the Femur from the Effects of Old Age.

soon after, thus accounting for the great shortening which is so often witnessed. The upper fragment, representing the head and a portion of the neck of the bone, on the contrary, remains attached to the round ligament, which thus supports and nourishes it, its supply of blood and nervous fluid being cut off in every other direction. This circumstance alone is sufficient to account for the fact that such a fracture cannot unite by osseous matter; but there are two other causes which powerfully contribute to such a result, the imperfect development of periosteum, and the large quantity of synovial fluid which is always poured out in the intracapsular fracture, the former disqualifying the fragments for the formation of callus, and the latter opposing their union.

Fractures of the neck of the femur are divisible into two classes, those which occur within the capsular ligament, and those which take place exterior to it; the former being now usually termed intracapsular, the latter extracapsular. The distinction is one of great pathological as well as practical importance, and is, therefore, worthy of profound consideration.

INTRACAPSULAR FRACTURES.

Fracture of the neck of the femur within the capsular ligament may occur at any portion of this part of the bone, as exhibited in the accompanying figs. 579, 580, and 581; but, in general, it is met with at a short distance below the head, or between the head and centre of the neck, where the compact structure is unusually weak, and where, consequently, the slightest force frequently produces the accident. Sometimes the line of fracture is on a level with the globular head, which, therefore, alone constitutes the upper fragment; and, on the other hand, cases are observed where the bone yields just above the attachment of the capsular ligament. Finally, the fracture is sometimes, although very rarely, partly within and partly without the ligament, forming an interesting variety, especially in reference to the question of the process of consolidation.

The direction of the fracture is usually more or less oblique; a strictly transverse fracture is a very uncommon occurrence; in rare cases, the bone is comminuted, as in a specimen in my private collection; and, now and then, the fracture is impacted, the upper extremity of the lower fragment being thrust into the cancellous structure of the superior. The head of the bone occasionally suffers along with the neck. The ends of the fragments are generally very sharp pointed, or spiculated.

An incomplete variety of intracapsular fracture is sometimes, although seldom, met with, a portion of the compact structure retaining its integrity, while the remainder yields under the force of the exciting cause of the accident. Again, instances occur in which, the fracture being complete, the ends of the fragments are temporarily retained

Fig. 579.   Fig. 580.

Illustrations of Intracapsular Fractures.

in apposition by the periosteum, thickened, perhaps, by inflammatory or ætal changes. A well marked example of an incomplete intracapsular fracture has been reported by Dr. J. B. S. Jackson, of Boston, as having happened in a man forty-two years of age, in consequence of a fall through two stories of a building upon a hard floor, breaking his spine and femur at several points. The fracture of the neck, commencing at its junction with the head, reached, as seen in fig. 582, nearly in a perpendicular direction, to within about a quarter of an inch of the inferior and internal wall of the bone, the fissure being so extensive that, if the man had been able to walk, the unbroken part could probably not have supported the weight of his body.
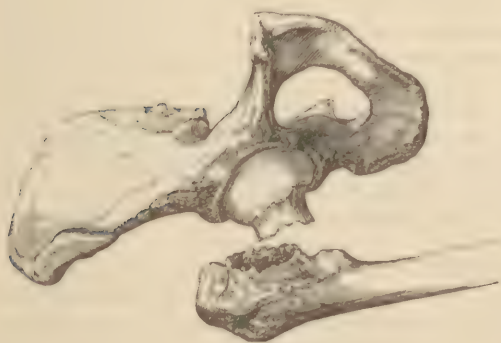
Fig. 581.   Fig. 582.

Intracapsular Fracture of the Femur.   Vertical Fracture of the Neck of the Femur.

The cause of intracapsular fracture is generally some trivial accident; most commonly a fall upon the great trochanter, or a blow upon the hip when the thigh is fixed and separated from its fellow, thus increasing the strain upon the upper portion of the bone. I have known the injury to be produced by the great toe catching in the fold of the carpet, while the person, an old lady of seventy-six, was walking across the floor.   In London, according to Sir Astley Cooper, it most frequently occurs from the foot suddenly

slipping off the edge of the side-walk over the curbstone, upon the horse pavement, the weight of the body being thus thrown forcibly upon the neck of the bone in a perpendicular direction, when it is unprepared for such an event. The fracture may also happen in turning awkwardly in bed, or in stepping carelessly out of bed upon the floor, the individual in either case powerfully twisting the thigh-bone. The fact that so serious a lesion may arise from so trivial a cause, while it is of great value in a diagnostic point of view, affords the clearest possible proof that a bone, liable to be so affected, cannot be very sound, but that, on the contrary, its structure must have undergone serious changes to render it capable of an accident which, in other pieces of the skeleton, requires an extraordinary degree of force. That this is true, as a principle, has already been shown, the immediate cause being a fatty, atrophied, and rarefied state of the compact and spongy tissues of the neck of the bone, the animal matter being absorbed, and the earthy alone left, the result of the whole being a weakened condition of the affected parts, and, consequently, a predisposition to fracture. Although the lesion is usually occasioned by slight accidents, instances are observed in which the reverse is the case, and it is then ordinarily also of a complicated character.

The age at which this variety of fracture occurs is, diagnostically considered, a matter of great importance. A fracture in other bones, or parts of a bone, may take place at any period of life, even in infancy and early childhood. Thus, I have seen the shaft of the femur itself broken in an infant of four weeks. But it is very different with the neck of this bone within the capsular ligament, experience having shown that it is subject to fracture only, as a rule, after the age of fifty, when, as already stated, its spongy and compact tissues suffer from atrophy and fatty degeneration, thus rendering it more or less brittle, and incapable of withstanding injury. The youngest subject in whom I have witnessed this fracture was a lady thirty-four years of age, the injury having been caused by a fall upon the hip; Mr. Stanley observed an instance at nineteen; Dr. William Hunt one at twenty-five; Bryant at twelve; and Dr. H. Wardner, of Illinois, one at fourteen. All such cases are, however, exceptional. The oldest subject in whom I have met with this fracture was a lady of ninety-four. The accident happened in a fall from her chair upon the floor, her general health being much impaired at the time. In Hunt's case the patient died from the effects of other injuries, and the dissection revealed the existence of a transverse fracture in the cervix immediately above the attachment of the capsular ligament. The accident took place in a railway train.

Sex also exerts a considerable influence upon the production of intracapsular fracture. Of its precise relative frequency in males and females, no reliable statistics, at least none upon a large scale, have been placed before the profession, although a sufficient amount of information has been obtained to justify the assertion that it is more common in the latter than in the former. In the tables of Mr. R. W. Smith, in his Treatise on Fractures, the sex is given in 28 cases, of which 17 were women and 11 were men. The cause of this difference appears to be twofold, the more horizontal position of the neck of the femur and the greater amount of atrophy and fatty degeneration of this portion of the bone in old females than in old males.

The intracapsular fracture may be complicated with fracture of the neck on the outside of the capsular ligament, the lines of disjunction running into each other. Such an occurrence, indeed, is not infrequent. Again, an intracapsular fracture may be associated with a fracture of the great trochanter; but this is extremely rare. In twenty-three specimens of this lesion in the Dupuytren Museum, at Paris, there is not a solitary example of such a coincidence.

The *symptoms* of intracapsular fracture are deserving of particular attention. They are: 1. Shortening of the thigh. 2. Eversion of the foot. 3. Preternatural mobility. 4. Crepitation. 5. Change of situation in the great trochanter. 6. Pain at the site of injury. 7. Peculiarity of the patient's body in the erect posture.

The *shortening of the thigh*, or of the limb through the thigh, is one of the most striking phenomena of this variety of fracture, and is the more valuable because of its almost universal occurrence. It is usually the first circumstance that attracts the attention of the surgeon, whether the patient is lying on his back or standing up. As might be expected, it varies in different cases and in different conditions of the same patient, its extent being greatly influenced by the state of the capsular ligament, being generally less in proportion to the integrity of this membrane, and conversely. It is always less immediately after the occurrence of the injury than it is after the lapse of several days, and also in impacted fracture than in the ordinary form of the accident. The amount of instantaneous shorten-

ing ranges from half an inch to an inch ; it may, however, be considerably less than this, not, perhaps, exceeding three lines ; and, on the other hand, it may reach an inch and a quarter, and even an inch and a half, especially if there be extensive laceration of the capsular ligament.   During the progress of the case, the shortening not unfrequently amounts to upwards of two inches, and in rare instances it has been known to exceed even three.

The diminution in the length of the limb, although generally immediate, is not always so, depending, perhaps, not so much, as has usually been supposed, upon the integrity of the capsular ligament, as upon the want of separation of the ends of the fragments, due to their peculiar denticulated condition, the incompleteness of the fracture, or the thickened and untorn condition of the periosteum, all tending to favor temporary contact of their surfaces.   It is hardly reasonable to imagine that, if the integrity of the capsular ligament were the only cause of it, this ligament would become so stretched or torn within so short a time after the accident as to admit of the amount of shortening above mentioned.   We must, therefore, seek for some other cause, and I know of none that is so plausible as the one here suggested.   Under such circumstances, the shortening generally takes place suddenly ; perhaps after the patient has made considerable exertion with his limb, several days, it may be, after the accident, from the instantaneous unlocking of the ends of the fragments.   When the fracture is impacted, the shortening will, of course, be immediate, and will also be likely to be permanent, unless the broken pieces be pulled forcibly asunder by the surgeon in the examination of the limb, or by the patient in his efforts at walking, sitting, or turning in bed.

Eversion of the foot, or rather, of the whole limb, is another striking symptom, seldom absent in any case.   When the patient stands up, it is such as to cause the heel of the affected side to point towards the hollow between the ankle and tendo Achillis of the sound limb ; while, when he is recumbent, the foot inclines outwards almost horizontally, dropping involuntarily upon its external surface, nearly or quite in contact with the floor or bed.   The eversion, although generally an immediate effect of the accident, does not always reach its maximum until some time after, depending upon the manner in which the ends of the fragments are held together.

The cause of the eversion is generally supposed to be the action of the external rotator muscles, which, as they are connected with the superior extremity of the bone, readily roll the thigh outwards when, from any circumstance, it has lost its support above, the irritation consequent upon the fracture being an additional incentive to contraction.   My own opinion, however, is that, although the external rotator muscles may not be wholly inoperative in the production of this occurrence, it is generally due, in a very great degree, if, indeed, not wholly, to the weight of the limb, the natural tendency of which is to eversion whenever it is free from restraint as the patient lies on his back.   In the impacted fracture, this symptom may be entirely absent, or, in other words, the limb, instead of being turned out, may be inverted ; and a similar occurrence is occasionally, although rarely, noticed in an intracapsular fracture, due, apparently, to the action of the adductor muscles of the thigh, aided, perhaps, by a rent in the inner portion of the capsular ligament ; or, if we adopt the explanation of the late Mr. R. W. Smith, of Dublin, to the manner in which, in such an event, the lower fragment is drawn up in front of the upper.   Examples of this occurrence have been recorded by Guthrie, Langstaff, Stanley, Cruveilhier, Hamilton, Hudson, Bigelow, and others.   A few cases have also been met with in which the foot pointed directly forwards, the limb being neither everted nor inverted.   Finally, it is possible, as Mr. Erichsen has stated, that cases may arise in which the inversion of the limb in an ordinary fracture may be due to paralysis of the muscles on its outer side.

Preternatural mobility, common to all fractures, is particularly observable in the intracapsular variety, and, therefore, serves as an important diagnostic sign of the accident. There are cases, however, in which it is absent ; in some entirely, as in the impacted fracture, and in others only in the early stage of the injury, as when the ends of the bone are held partially together by the interlocking of their fibres, by the incompleteness of the solution of continuity, or by some other cause.   Its existence, as well as its degree, is always readily ascertained by taking hold of the limb and rotating it upon its axis, or flexing it upon the pelvis, extending it behind the line of the sound limb, or carrying it inwards or outwards ; movements which cannot be executed when there is a dislocation of the head of the femur.   Extension and counterextension will have the effect of restoring the limb promptly to its proper length, but as soon as the forces are discontinued the original shortening is reproduced.

Crepitation, the most valuable sign of all in fractures generally, is rarely wanting in this. Indeed, it can only be absent in the impacted form of the lesion, or in those rare cases where the ends of the fragments remain still partially in apposition with each other. It is usually discoverable immediately after the accident, and may, of course, be elicited as long as the fracture continues ununited. In order to determine its existence, it is necessary to bring the ends of the broken bone fully into contact by extension and counter-extension, when, upon rotating the limb, it will at once declare itself, although in many cases it is very faint.

Change of position in the *great trochanter* is always a symptom of much importance in intracapsular fracture. This bony prominence is not only drawn upwards towards the ilium, but it is brought in close contact with the border of the acetabulum, and is, therefore, much less easily felt and seen than in the normal state, in which it is always so conspicuous. Moreover, when the thigh is rotated upon its axis by taking hold of the foot, the great trochanter will be found to turn, as it were, upon a pivot, or to move in a segment of a lesser circle than natural. From the circumstance of the limb being generally strongly everted, the portion of the broken neck attached to the trochanter is directed inwards and upwards, and is thus placed in closer proximity with the anterior superior spinous process of the ilium than the trochanter itself.

Another sign upon which much stress is laid is the condition of the fascia lata. In the natural state this fascia is in a state of tension; but in fracture of the neck of the thigh-bone it is, as was first pointed out by Dr. Allis, invariably more or less relaxed between the great trochanter and the crest of the ilium.

To determine the existence and the amount of shortening in fractures of the neck of the thigh-bone, Mr. Bryant's test-line, as it is termed, will be found to be of great value.

Fig. 583.
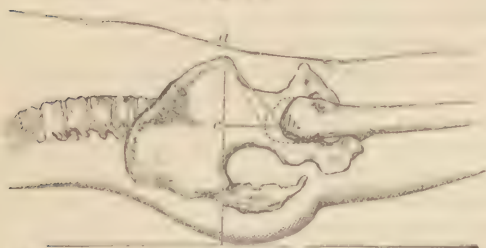
The ilio-femoral rectangle *a c b*. *c b* test line for fracture or shortening of the neck of the thigh-bone.

"For purposes of demonstration," says the English surgeon, "I have described it as the base of the ilio-femoral triangle, *c b*, fig. 583, the two sides of the triangle being made up of two lines drawn from the anterior superior spinous process of the ilium, one of them, *a c*, being vertical, and traversing the outside of the hip to the horizontal plane of the body; and the second, *a b*, impinging on the tip of the trochanter major and corresponding in the normal condition of the hip-joint to the anterior half of Nélaton's test-line for dislocation of the head of the femur backwards.

"The 'test line' *c b* for fracture or shortening of the neck, joins the two at *right angles* to the vertical line, and extends from it to the trochanter.

"Any shortening of this line, on comparing it with the same taken on the uninjured side, indicates with precision a shortening of the neck of the thigh-bone; and, when the shortening has followed at once upon an injury, fracture of the neck of the thigh-bone, impacted or otherwise, is certain. Compared with this line, all other measurements are uncertain. By its use, manipulations of the injured limb are often rendered unnecessary. For practical purposes, the vertical line *a c* and the test line *c b* are alone required. To compare the two sides of the body, it is necessary to see that the pelvis is straight."

Pain at the site of injury, being common to all fractures, is of special value only in connection with the other symptoms already described. It derives its chief importance from the fact that it is located at the upper and inner part of the thigh, in the direction of the small trochanter, and that it is always greatly increased whenever an attempt is made to rotate the limb, to bend it upon the pelvis, or to carry it inwards over the sound one. When the patient is perfectly quiet, with the limb in a relaxed position, the suffering is usually very trivial, except when the bone, in addition to the fracture, has been severely concussed or contused, when the pain will frequently be excessive. It is generally worse, too, at night than in the day, and in wet weather than in dry.

There is a peculiarity in the patient's *attitude* as he stands up, which cannot fail to strike the most careless observer. The body, in this position, is inclined forwards in such a manner as to throw its weight upon the sound limb, which is firmly planted upon the floor, while the other hangs off in a constrained, unseemly, and awkward manner; the foot and knee are strongly everted; the leg is supported upon the ball of the toes, while the heel, resting in the interval between the ankle and tendo Achillis, is elevated from

two to three inches from the surface; the natural prominence of the hip is destroyed; and the least attempt to walk or to raise the limb not only proves abortive, but is productive of exquisite pain.

Finally, there is seldom much *swelling* in this variety of fracture; it is only when the hip has been struck a severe blow that the superficial parts are likely to be the seat of any considerable effusion, ecchymosis, discoloration, or contusion, and even then the symptoms are usually very evanescent.

The *pathological changes* in intracapsular fracture vary very much, according to the period of the examination, as well as the character of the original injury. In recent cases there is usually some sanguineous effusion, although the quantity of blood is generally very small, unless, as occasionally happens, there is extensive rupture of the capsular ligament, when it may be considerable. Most commonly the ligament preserves its integrity, but if the accident has been unusually severe it may be torn at one or more points, so as to admit of the partial escape of the inferior fragment, the soft covering of which is often partially detached, hanging off in loose, irregular shreds. If several days have elapsed since the receipt of the injury, the synovial membrane will be observed to be unnaturally vascular, and slightly coated with plastic matter, a small quantity of which is also sometimes found upon the ends of the fragments. There is likewise, at this stage, a marked increase of synovial fluid, and the structures around the joint frequently exhibit a contused appearance, with more or less infiltration of blood and serum.

If the dissection be made after the lapse of some months, the capsular ligament will be found to be much thickened by interstitial deposits, as well as by the addition of plastic matter to its synovial lining; the head and neck of the bone are also incrusted with lymph; and the ends of the fragments are softened, unnaturally vascular, and rounded off, or partially connected by fibro-ligamentous bands. The interarticular ligament retains its normal structure, except in rare cases, in which it is inflamed and changed into fibrous tissue.

In old cases, or such as have lasted for some years, there are not only great thickening and induration of the capsular ligament, but extraordinary alterations in the broken bone, the neck of which is often completely annihilated, the shaft terminating abruptly on a line with the two trochanters. At other times the neck is converted into a short, conical knob, partially incrusted with cartilage, or scooped out, as it were, into a cup-like depression. The trochanters themselves are occasionally a good deal changed in their appearance, especially the great, which is liable to be diminished in size and altered in configuration. The head of the bone generally retains its position in the acetabulum, but that portion of the neck which remained attached to it at the time of the accident is usually

Fig. 584.   Fig. 585.

Senile Atrophy of the Neck of the Femur.   Atrophy which might be mistaken for United Fracture.

totally absorbed; and cases occur, although rarely, where the entire fragment is either destroyed or represented by the merest possible remnant held in place by the round ligament. When the head is left, its lower surface is occasionally hollowed out into a kind of

socket for the reception of the rounded conical end of the lower fragment ; or the reverse obtains, the head being rounded off, and the lower fragment scooped out. In either event, the two extremities, continually moving upon each other, in time acquire a smooth, polished, eburnized character, the better qualifying them for the performance of their various functions.

The changes now described are sometimes closely imitated by those produced in the head and neck of the femur by a fall or blow on the hip, leading to interstitial absorption of the osseous tissue, and to shortening of the limb, with destruction of the articular cartilage and eburnization of the resulting stump, very much as in arthritic rheumatism. There is reason to believe that cases of this kind are not unfrequently mistaken, both during life and after death, for fractures of the neck of this bone. The appearances here alluded to are well illustrated in figs. 584 and 585.

The *mode of repair* of intracapsular fractures is peculiar. Ordinary fractures generally unite by osseous matter, but in this variety of injury the connecting medium is of a fibro-ligamentous nature, as in similar lesions of the olecranon process, the patella, and the skull. But it is not always that the surgeon is to look even for such a union, imperfect as it is; in many cases the ends of the broken bone utterly refuse to unite, being gradually rounded off, and, perhaps, slightly incrusted with cartilage, or, as not unfrequently happens, especially in very aged and decrepit subjects, becoming, in time, completely absorbed, the lower fragment disappearing as far down as the two trochanters, and the upper as high up as the brim of the acetabulum. In rare cases, indeed, even the entire head is removed, along with the greater portion both of the round and capsular ligaments.

Fig. 586.

Fracture of the Neck of the Thigh-bone, United by Fibrous Tissue.

A very excellent idea of the fibro-ligamentous union of this variety of fracture is afforded in fig. 586, from Sir Astley Cooper. It was taken nine months after the accident, from a patient between thirty and forty years of age.

The causes of this want of union are of easy recognition. In the first place, the parts have to encounter the prejudicial influence which results from the difficulty of maintaining accurate apposition of the broken ends of the bone; a circumstance which is so essential to the successful repair of fractures in other pieces of the skeleton, but which is almost impossible to effect here, in consequence of the want of proper leverage in the upper fragment. All the apparatus that has yet been devised for the purpose has utterly failed to accomplish the object; whatever may be done, more or less motion is inevitable. Secondly, the accident is always followed by a considerable degree of synovitis, and, as a necessary result, by an increased quantity of synovial fluid, which, bathing the ends of the bone, acts inimically to the consolidating process. Thirdly, the most important reason, however, of all, is the want of power in the parts to furnish the requisite amount of plastic matter from the injury sustained by their vessels and nerves at the time of the accident. The superior and smaller fragment, represented by the globular head of the bone, or the head and a little remnant of the neck, is solely dependent for its vascular and nervous supplies upon the round ligament, and every one who knows how small this ligament is, and how insignificant its vessels are in the natural state, must be aware how utterly inadequate it must be for the nourishment of the bone to which it is attached. It need not, then, be wondered at that there never is any osseous matter effused by this fragment. Nor does the inferior fragment fare much, if any, better in this respect. Destitute, in great measure, of periosteum, with many of its vessels in a hopelessly lacerated condition, its powers are too feeble to afford any substantial aid in the process of repair. Hence the result must necessarily always be as above stated; that is, there will either be no union at all, or, if an attempt is made at establishing a connection between the two fragments, that attempt will go no further than the formation of a fibro-ligamentous substance.

When no effort whatever at repair occurs, the ends of the fragments speedily undergo the fatty degeneration, and fall an easy prey to the action of the absorbent vessels, eventuating in their partial destruction or complete annihilation.

It would, perhaps, be going too far to deny altogether the possibility of bony union in

intracapsular fracture of the thigh-bone, and yet I have certainly never seen what I could regard as an unequivocal example of the kind.   I have examined most of the specimens in this country, purporting to be cases of osseous consolidation, and in no instance have the appearances been such as, in my opinion, to justify such a conclusion.   The history of these cases has generally either been so exceedingly defective, or the necroscopic characters have so closely resembled those witnessed in the changes which the head and neck of the femur undergo in consequence of old age or disease, as to destroy all confidence in their authenticity as genuine examples of intracapsular fracture.   I need not insist here upon the great difficulty which the practitioner frequently encounters in establishing a correct diagnosis in injuries about the hip; what skill and care are generally required to discriminate accurately between a mere sprain and a fracture, or a fracture and a dislocation; or how frequently even slight lesions of the ilio-femoral articulation, and of the head and neck of the femur, are followed by changes in the structure and conformation of these portions of bone which so closely simulate those produced by fracture as to deceive the most enlightened and cautious observer.

The question, then, in regard to the repair of intracapsular fracture, resolves itself into four groups of facts, which may be thus stated:—1. Under favorable circumstances, both as it respects the patient and the treatment, there may be fibro-ligamentous union, answering the purpose of a sufficiently strong bond to admit of tolerable progression after recovery from the more immediate effects of the accident.   2. Under adverse circumstances, that is, when the patient is old, decrepit, or worn out by disease, and cannot, in consequence, submit to proper treatment, or when, although the system is sufficiently vigorous, the case has been injudiciously managed, no consolidation whatever will take place, and not only so, but the neck of the bone, or both the neck and head, will be absorbed, the limb remaining, of course, permanently shortened and deformed.   3. Osseous union, although, perhaps, not wholly impossible, is yet so exceedingly infrequent that it cannot reasonably be looked for in any case, however propitious the circumstances attending it, both as it respects the patient and the skill and attention of his attendant.   The event, other things being equal, will be most likely to happen in the impacted form of the injury, and in the ordinary fracture in comparatively young and robust persons.   4. When the fracture is of a mixed character, that is, partly within and partly without the capsular ligament, the mode of repair will be similar to that of ordinary fracture, although the process will require more time and care for its successful completion.

The *prognosis* in this variety of fracture is embraced in the above remarks respecting its repair, and need not, therefore, engage further attention here.   In regard to life, the danger is generally inconsiderable, as the lesion is usually the result of very trivial accidents, involving no serious injury to the soft parts, or any comminution of the bone.   I have, however, seen several instances in old, dilapidated subjects, followed by death from shock, or shock and its effects.   In the case of an old lady ninety-four years of age, recently under my observation, death was produced by gradual exhaustion from excessive pain and want of appetite.   In regard to the limb, as the consolidation of the fracture is always more or less imperfect, its usefulness will necessarily be impaired in a degree proportionate to the defective character of the connecting medium.   For a long time the patient will be obliged to employ a crutch, but eventually he will be able to walk with the aid of a stick and a high-heeled shoe, the parts strengthening by exercise, notwithstanding there is a strong tendency to atrophy of the muscles.   The hip-joint generally remains permanently weak, and it is seldom that the patient does not experience more or less pain in it, often of a neuralgic, gouty, or rheumatic character.

Treatment.—Fractures of the neck of the femur within the capsular ligament are not, I think, generally so well managed as they should be, owing chiefly, if not wholly, to the influence of the writings of Sir Astley Cooper, who taught that, inasmuch as there never is any osseous union in this variety of injury, it is not, therefore, proper to torture the patient with a protracted confinement in the recumbent posture, and the application of an extending apparatus.   He considered such a proceeding the more necessary because a great majority of the subjects of this fracture are old and decrepit persons, many of whom bear confinement very badly, soon becoming affected with foul bed-sores, and eventually perishing from hectic irritation or congestive pneumonia.   In accordance with this view, he was in the habit of placing the limb upon a long pillow, in an easy position, for about a fortnight, or until the pain and inflammation, consequent upon the accident, had in great measure subsided.   The patient was then allowed to leave his bed, and sit in a high chair, or exercise upon crutches, care being taken to bear, at first, very gently upon the foot, for fear of disturbing and fretting the ends of the fragments.   Subsequently, as the limb

improved in strength, a high-heeled shoe was ordered, and a stick was substituted for the crutches.

If this treatment were the exception, and not the rule, every practitioner of sense and experience would concur in its propriety; but the English surgeon, in his desire to generalize it, has carried it much further than the interests of our patients justify. It is unquestionably true that many of the subjects of intracapsular fracture do not bear confinement well; they suffer from the slightest restraint, and soon become bedridden. Such cases are extremely difficult to manage, and are not likely to be benefited by the use of splints, or any other mechanical contrivances calculated to compress the limb and hold it in an uneasy and constrained position. To this class the treatment of Sir Astley Cooper is peculiarly applicable; indeed, no other can be employed. All that can be done is to make the patient comfortable, and let the limb get on as best it may. But there is another class of subjects, who, although perhaps a good deal advanced in years, are, nevertheless, quite stout and robust, enjoying excellent health at the time of the injury, whose constitution has never been impaired by intemperance or excess of any kind, and who can bear the long confinement incident to such an accident with the most perfect impunity. The persons composing this class are, for the most part, residents of the country, and not the poor, broken-down inhabitants of the crowded city, without any bodily vigor, or any recuperative power. Hence, no exclusive plan of treatment should be adopted; but the management should be varied according to the exigencies of each particular case. Such a course is the more necessary because it is utterly impossible always to determine positively, by the most careful examination, whether the injury is one purely of intracapsular or extracapsular fracture, or whether it partakes, as, indeed, it not unfrequently does, of the character of both, the two being conjoined.

Acting upon the above principles, I have, for many years, treated most of the cases of intracapsular fracture that have come under my notice as any other fracture of the femur, by permanent extension and counterextension, not with the hope, as already stated, of obtaining bony consolidation, but with the view simply of keeping the ends of the fragments more accurately in contact, and thus affording them an opportunity of becoming united by fibro-ligamentous tissue. It is obvious that such a result can only reasonably be anticipated when this condition is fully complied with. When the broken pieces are permitted to overlap each other constantly, hardly any union will be possible, certainly none of a useful kind; and there is, moreover, in such a condition, always great risk that at least the neck, if not also the greater portion of the head, of the bone, will be absorbed, and the patient, in consequence, never regain the functions of his limb. If the treatment fail, the surgeon has the consolation to know that he has discharged his duty, by having kept the parts in the only position in which it is ever possible for them to unite in any way. The thigh may be maintained in the extended position, and among the apparatuses

Fig. 587.

Daniel's Fracture-Bed.

which best fulfil this indication is that depicted at page 1009, extension and counterextension being made by the usual means. A splint of unoiled sole leather, well padded, and furnished with straps at the upper extremity, and carefully secured to the inner side of

the limb will be required to give due support to the ends of the fragments, or to prevent inward displacement. The splint should reach from the knee high up into the groin, inclose fully one-half of the thigh, be well fastened with a water-glass roller, and be attached by means of its two straps to a cord playing over a pulley with a weight of six, eight, or ten pounds, according to the age of the patient and the tendency to displacement. The object of this arrangement is to keep up a certain degree of lateral or oblique extension in order to effect and maintain more accurate apposition of the ends of the fragments than is possible by mere longitudinal extension. Good cures may also be obtained by placing the limb over a double inclined plane; or, what is better, when it can be procured, the patient may be put upon a Daniel's fracture-bed, represented in fig. 587. The latter contrivance, which, unfortunately, however, is too expensive for general private use, is particularly adapted to cases of old persons likely to require protracted confinement. The bed is so arranged that, while the patient can sit up, or vary his position, efficient extension and counterextension may be maintaned with adhesive strips. An elaborate description of the apparatus may be found in the tenth volume of the Transactions of the American Medical Association.

When a Daniel's fracture-bed cannot be obtained, a most excellent, as well as a comparatively cheap, substitute may be found in what is known as the Charleston reclining chair, fig. 588, modified and improved by Professor William H. Pancoast, the most important additions being a bed-pan and a movable footboard. The chair, made very strong and wide, is well stuffed, and arranged in the form of a double inclined plane, the patient, by means of pillows and other appliances, being thus rendered far more comfortable than he can be in any ordinary bed, the more especially as he can at any time shift his posture without any detriment to the affected parts. Professor Pancoast finds that this contrivance is peculiarly adapted to the treatment of fractures of

Fig. 588.

Reclining Chair.

the upper extremity of the thigh-bone in elderly subjects, having employed it successfully in a number of cases, with very little shortening of the limb in any. Apposition of the ends of the fragments is effected by means of compresses and short splints, confined by adhesive plaster and bandage, or the immovable dressing.

Whatever plan of treatment be adopted, its effects should be most carefully watched, so that it may not prove irksome, much less injurious. Particular care should be taken to see that the great trochanter preserves its natural prominence. Any flattening of the hip may be regarded as an evidence that there is inward displacement of the ends of the fragments, and danger of a want of ultimate reunion. The length of time during which the patient should be confined must vary, on an average, from ten weeks to three months and a half. During all this trying period he should be on a full allowance of meat and porter; at all events, upon a generous diet, in order to sustain the system and promote repair. Purgative medicines and all other depressing means should be used as sparingly as possible. Anodynes, if necessary, must be freely given in the evening to allay pain and procure sleep.

When the patient is able to move about he will derive great comfort from the use of a Willard's double hinge-joint apparatus, delineated in the section on tuberculosis of the hip-joint; one part corresponding with the thigh and the other with the hip and lower part of the trunk.

EXTRACAPSULAR FRACTURES.

The extracapsular fracture is situated at the base of the neck of the femur, extending from above downwards and from behind forwards in the direction of the intertrochanteric line. It is not always, however, as the name declares, strictly exterior to the capsular ligament; on the contrary, it occasionally passes above the attachment of that structure,

so as to partake of the character both of an inner and of an outer fracture of the neck, constituting what may be called a mixed fracture. Moreover, the injury is always associated with fracture of the trochanters, sometimes with one, at other times with both, thus leaving in the former case three fragments, and four in the latter. Again, the fracture is often comminuted independently of its connection with the trochanters; and in many instances it is attended with more or less penetration of the superior piece into the inferior. Observation, however, induces me to believe that, generally speaking, the penetra-

Fig. 589.   Fig. 590.

Extracapsular Fracture of the Femur.   Comminuted Fracture of the Upper Extremity of the Femur.

tion is very trivial, hardly ever exceeding three lines, and often not reaching even so high as that. Figs. 589 and 590 afford a good idea of the situation and direction of the extracapsular fracture.

In regard to the frequency of the occurrence of impaction in this lesion opinion varies. Robert W. Smith, of Dublin, asserts that all extracapsular fractures are, in the first instance, also impacted fractures; a statement which should be received with a considerable degree of allowance, for examples are certainly occasionally seen in which the reverse is the case.

The extracapsular fracture is not so common as the intracapsular; the difference, however, is trivial. Men are somewhat more subject to it than women, and, while it may take place at any period of life, experience teaches that by far the greater number of cases occur after the sixtieth year. It may be stated, as a rule, that a much greater amount of violence is required to produce this fracture than the intracapsular, but the rule admits of many exceptions. The most common exciting cause is a fall or blow upon the hip, in the direction of the great trochanter; it may also follow a fall upon the foot or knee, and the passage of the wheel of a carriage across the pelvis or upper part of the limb. Finally, cases occur where it happens from the body being crushed by a heavy load descending upon the back, the lower extremities being in a fixed state at the moment of the accident. In not a few instances, however, the fracture is occasioned by very slight causes, while in most there is reason to believe that the bone at the site of the lesion is in a remarkably brittle condition, predisposing it to the disruption of its fibres. In some of the preparations that I have examined in different osteological collections, the compact structure, although not very materially diminished in thickness, was almost of a vitreous consistence, while the spongy was extremely rarefied and expanded, thus occasioning great weakness of the part. The cervical portion of the bone, under such circumstances, frequently retains a remarkably healthy appearance. When the osseous tissue is so very fragile at this point, it is not improbable that it may occasionally give way under mere muscular contraction, as has happened in at least one well-authenticated case, the patient, a woman, eighty-three years of age, having met with the accident in an effort to preserve her equilibrium in the act of falling.

The *symptoms* of this variety of fracture bear a strong resemblance to those of the

intracapsular, some existing in a less, others in a greater, degree, but none, considered separately, possessing any diagnostic value.   In describing these symptoms it will be most satisfactory if they be presented in the same order as in the preceding case.

The *shortening*, which is a constant occurrence, varies from half an inch to an inch, as its minimum, to an inch and a half, as its maximum.   In exceptional cases it may, however, amount to two inches and upwards.   It is usually most distinct when there is a badly comminuted state of the bone, or when the great trochanter, forming a part of the upper fragment, is drawn uncommonly far outwards, so as to permit the lower fragment to ride considerably over the upper.   Moreover, it possesses the peculiarity of being generally as great immediately after the fracture as at any subsequent period.

The hip, as the result of these changes in the position of the great trochanter, is more or less flattened; and the femoral aponeurosis, as has been shown by Dr. Oscar Allis, will be found to be relaxed on the affected side when the patient stands up.

The knee and foot are generally *everted*, the limb lying as if it were perfectly powerless, the muscles having apparently lost all influence over it.   This symptom is even more striking than in the intracapsular fracture.   Eversion, however, is not so constant an occurrence as in the latter accident; in a considerable proportion of cases the limb is strongly rotated inwards, and in both varieties, but especially in the former, the displacement is occasionally so obstinate as to require an unusual degree of force to rectify it, depending, doubtless, upon the interlocking of the fragments.

The extracapsular fracture is characterized by complete *mobility* of its fragments, except when they are impacted, an occurrence which, as just stated, is more common here than in fracture within the capsule.   The loss of function is also complete, the patient being unable to lift the limb by the effort of his muscles, or to execute any of its natural movements.

The *crepitation* is generally very distinct, being often loud and cracking, and is readily perceived by the hand and ear, applied to the hip when the limb is rotated upon its axis. It is usually more marked than in intracapsular fracture, and does not, as in the latter, require extension and counterextension for its production.   When the fracture is badly comminuted, the fragments may often be readily detected with the fingers, and be made to move upon each other so as to emit a grating sound not unlike that caused by rubbing together several pieces of broken china.

The position of the great *trochanter* may be the same as in the intracapsular fracture, obeying the movements of the limb, and turning, as it were, upon a pivot, describing the segment of a lesser circle, as it does in the natural state.   In many cases, however, it is completely detached, and then, of course, it either remains stationary on rotating the foot, or it follows the inferior fragment as a separate body.   In general, it will be found to be somewhat farther off from the spine of the ilium than in the intracapsular fracture, depending upon the smaller amount of retraction of the limb.

The *pain* is always unusually severe, and is greatly increased by every attempt at motion and manipulation; it is more superficial than in intracapsular fracture, and is concentrated, as it were, upon the two trochanters.

The *swelling* is also uncommonly extensive, and there is nearly always considerable discoloration of the surface, owing to the contused and ecchymosed condition of the skin and subcutaneous connective tissue, the latter of which is often extensively infiltrated with blood.

The *attitude* of the patient possesses nothing peculiar; it partakes of the same general character as in intracapsular fracture, and, in fact, so closely simulates it as to be with difficulty distinguished from it.

Finally, along with the symptoms now described, there is generally, in extracapsular fracture, evidence of severe shock immediately after the occurrence of the accident, and the resulting reaction is not unfrequently followed by high fever, lasting often for a number of days, and requiring great attention on the part of the professional attendant.   In intracapsular fracture the patient may feel very faint, but he soon recovers, and has afterwards seldom much constitutional disturbance.

Repair of the extracapsular fracture is effected precisely in the same manner as in fracture of any other piece of the skeleton provided with periosteum.   It differs, therefore, wholly, in this respect, from that of the intracapsular form of the lesion.   Here osseous union is the rule, the want of it the exception, the reverse being the case in intracapsular fracture.   The period at which the consolidation is completed will, of course, depend, as a general rule, upon the age and health of the patient, the presence or absence of complications, and, above all, upon the care which is observed in keeping the ends of the fragments in accurate apposition.

Although the extracapsular fracture invariably unites by osseous matter, the *prognosis*

is very far from being always favorable either as it respects the possibility of avoiding deformity and lameness, or our ability to save the patient. When the fracture is comminuted, or the bone is broken into a number of pieces, including the two trochanters, a good result is hardly to be anticipated even under the most judicious management. Under such circumstances, the neck of the bone, having lost its support, is pushed downwards and inwards below its natural level, and a certain degree of shortening with deformity of the upper part of the thigh will be inevitable. The same result must necessarily follow when the fracture is impacted. These facts should be well studied and appreciated, and should always be promptly communicated to the patient, lest, when the cure is completed, he should blame his attendant for making him a bad limb when it was impossible to make a good one.

From the great violence that is so frequently inflicted upon the parts, both soft and hard, the extracapsular fracture often proves hazardous both to limb and life. Occasionally, although rarely, the patient dies from shock : in some instances he suffers greatly from the effects of excessive reaction. Most generally, however, when there is danger, life is put in jeopardy by the supervention of erysipelas or pyemia, the former commonly setting in within the first forty-eight hours from the occurrence of the fracture, and the latter towards the end of the first week or the beginning of the second. Some idea of the danger of extracapsular fracture may be formed when it is stated that, of eighteen cases treated in the Richmond Hospital at Dublin, nine proved fatal, the period of death ranging from the fifth to the fifteenth day. In some cases the patient sinks from the exhaustion consequent upon extensive suppuration or the formation of large sloughs over the sacrum and buttocks from protracted confinement in one position.

The *treatment* of extracapsular fracture differs in no wise from that which is necessary in fracture of the shaft of the bone. The limb, placed in the straight position, is kept perfectly at rest by means of splints, stretched along its outer and inner surfaces, and connected below in such a manner as to admit of the requisite extension and counterextension until a cure is effected. The foot should incline slightly outwards to favor relaxation of the external rotator muscles, and special care should be taken to prevent overlapping of the fragments, or angular deformity, by the use of a gutta-percha splint, accurately moulded to the outer and anterior part of the thigh, and well secured by the bandage. The dressing should be continued for at least six weeks.

IMPACTED FRACTURES OF THE NECK OF THE FEMUR.

Fracture of the neck of the femur occasionally presents itself as an impacted lesion, the lower extremity of the upper fragment being forcibly impelled into the cancellated structure of the upper end of the lower fragment, the great trochanter being usually carried along with the descending portion. The accident, which is sufficiently rare, and of which fig. 591, from a specimen in the Mütter collection, affords a beautiful illustration, is nearly always associated with the extracapsular fracture, and occurs under two varieties of form, the complete and the incomplete, of which the latter is by far the

Fig. 591.

Fig. 592.

Impacted Fracture of the Neck of the Femur.
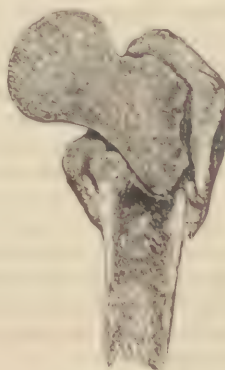
Impacted Fracture through the Trochanter, the Upper Fragment being Wedged into the Lower.

more frequent. Old persons only are subject to it, and it is most common in those in whom the neck of the femur is of inordinate volume from the expansion of its spongy structure. The line of fracture is generally at the base of the neck, or at the junction of the neck with the shaft, the penetration occurring in the direction of the anterior surface of the bone, with which the neck is more immediately continuous, being separated from it behind by a well-marked depression, and by the large ridge connecting the two trochanters. The fracture usually happens from the body being crushed by the falling of a heavy substance upon the trunk, while the chest is inclined forwards, and the knee rests upon a solid surface, the hip at the same time receiving a severe blow, as when a person is buried by the caving in of a coal-bank ; or, it may be produced by a fall from a height upon the knee, in which the weight of the body is violently impelled in the opposite direction, the two forces continuing to act after the bony tissues have given way. The direction of the fracture is generally oblique, extending from above downwards from the great to the small trochanter, both of which are not unfrequently included in the injury, as in fig. 592.

The distance at which the upper fragment is buried in the lower varies from a few lines to half an inch, three-quarters of an inch, or even an inch, depending upon the degree of the impelling force and the amount of expansion of the cancellated structure at the base of the cervix. The compact substance of both fragments is often extensively comminuted, and the fragments themselves are usually interlocked in such a manner as to give the thigh-bone the appearance of being twisted upon its axis, the limb after the accident being generally everted, as in fracture without impaction, although in a less marked degree.

In this form of impacted fracture, Professor Bigelow is of opinion that, in the large majority of cases, the thin, friable posterior wall of the neck of the bone alone is driven into the trochanter, while the thick anterior wall remains free, its dense and more resisting structure refusing to yield except as a kind of hinge upon which the shaft rotates at the moment of the accident. To this circumstance may be ascribed the eversion of the foot, while the shortening is generally due to the obliquity of its hinge, which follows the anterior intertrochanteric line.

There is a variety of impacted fracture of the neck of the femur in which the lower fragment is impelled into the reticulated structure of the upper. The occurrence is uncommon, and the amount of shortening is a good deal less than in the more ordinary form of injury.

The *symptoms* of impacted fracture of the neck of the femur are generally very characteristic, although a good deal of care is necessary, in every case, in order to make a correct diagnosis. The most valuable and reliable phenomena are, the shortening of the thigh, the eversion of the foot, the ability of the patient to walk or to bear the weight of the body upon the thigh, after the accident, and the resistance which the fragments offer to extension and counterextension when an attempt is made to restore the limb to its natural position. The pain is usually very intense, generally much more so than in ordinary cervical fracture, and there is not unfrequently extensive ecchymosis over the great trochanter, causing unwonted swelling and discoloration. Crepitation can only be elicited by unlocking the ends of the fragments.

The degree of shortening varies, as already stated, from a few lines to an inch or more, the average ranging from a quarter of an inch to half an inch, which it rarely exceeds. The eversion of the foot, although well marked, generally exists in a slighter degree than in fracture of the neck of the bone without penetration, whether the injury is seated on the outside or within the capsular ligament. The occurrence is the more valuable as a diagnostic from the fact that it is rarely, if ever, entirely absent. As the continuity of the femur is preserved, the patient is generally able to walk after the accident, although not without much suffering, or, at all events, he can bear the weight of his body upon the affected member. For the same reason, the limb is easily rotated upon its axis, bent upon the pelvis, extended, abducted, or adducted ; and when an attempt is made to restore it to its normal length, the effort, unless very powerful, ordinarily fails, the ends of the fragments retaining their interlocked position, despite the extension and counterextension. Finally, there is generally, in addition to the symptoms now described, more or less deformity, although this cannot always be easily detected on account of the excessive swelling, and, when present, is not, of course, characteristic.

What, then, are the most important phenomena in a diagnostic point of view ? Beyond all doubt, the shortening of the thigh, the immobility of the limb, the existence of deformity at the hip, in the situation of the great trochanter, and the absence of crepitation. When

these signs are present, it may be assumed that there is no dislocation of the ilio-femoral joint, nor any ordinary fracture of the neck of the femur, but fracture of this portion of the bone with impaction of the uppper fragment.

The *prognosis* of this variety of fracture is much more favorable, so far as it respects reunion, than that of ordinary fracture of the cervix ; for, inasmuch as the fragments are firmly wedged together, it usually requires but little callus to effect their consolidation. Besides, very little retentive apparatus is usually necessary, the two fragments serving as their own splints. On the other hand, however, there must always remain a certain degree of deformity, consisting of slight shortening of the limb, and of an incurvated state of the thigh just below the hip. Some permanent lameness may, therefore, reasonably be looked for after the accident, even under the most favorable circumstances. I have seen several specimens of impacted fracture of the neck of the femur where great and irremediable ankylosis was produced by osseous matter being extended, in the form of bridges, from the seat of injury to the innominate bone, immediately around the acetabulum, connecting the two together in a solid mass.

These protective means are displayed in a remarkable manner in a specimen, above depicted, of impacted fracture of the neck of the left femur, in the Mütter collection. The head and neck of the bone, being nearly two inches and three-quarters in length, occupy a horizontal position in regard to the shaft, the neck being driven into the cancellated structure of the latter some distance below the trochanters. The superior third, or more, of the shaft is bent strongly forwards and outwards, and is surrounded by a casing of new osseous matter, more than half an inch in thickness at the concavity of the curve, or weakest portion of the femur, and at a point, consequently, where, after such an accident, the greatest amount of support is required. A large ledge of bone, two inches long, and very broad, thick, and firm, projects from the anterior and inner aspect of the superior extremity over towards the hip-joint, being connected by a strong, round ligament, upwards of two inches in length, with the anterior inferior spinous process of the ilium, which juts out as a remarkably long, slender prominence, more than twice the normal size. An idea of the amount of shortening of the femur may be formed, when it is stated that the summit of the great trochanter projected fully one inch above the upper border of the acetabulum. Nothing is known of the history of the case ; but, judging from the completeness of the reparation, the accident must have occurred many years before death. Some degree of motion, certainly very slight, must have existed both in the acetabulum and at the junction of the two fragments, the upper end of the lower of which was converted into a socket into which the lower end of the upper was received, a kind of adventitious membrane having been interposed between the contiguous surfaces.

In the treatment of this fracture, one important point is not to pull the ends of the broken bone asunder in the examination of the case. Hence, whenever impaction is suspected, the rule is to refrain from all rotation and extension. As soon as the nature of the accident is detected, the limb is placed in an easy position in bed, a pillow lying under the ham, and gentle but steady pressure is made, by means of a compress and bandage, in the direction of the great trochanter, with a view of rectifying any deformity that may exist in that situation. Generally, no splint will be required, but sand bags may be useful ; and in ordinary cases the patient will be able to move about on crutches in three or four weeks.

General Diagnosis.—Fractures of the neck of the thigh-bone are liable to be mistaken for other lesions, and it is, therefore, a matter of great importance to have accurate conceptions of their real nature, errors of diagnosis here being always particularly prejudicial both to the patient and to the practitioner. The affections with which they are most apt to be confounded are sprains and dislocations of the hip-joint ; and, in many cases, great difficulty is also experienced in deciding whether the injury is one of fracture within the capsular ligament, or of fracture exterior to it.

The symptoms of fracture of the neck of the femur, especially the intracapsular, are sometimes closely simulated by sprains and contusions of the hip, causing involuntary obliquity of the pelvis, with apparent shortening of the limb, and eversion of the knee and foot, along with excessive pain and difficulty of motion. The resemblance is occasionally so perplexing as to create doubt in the mind of the most skilful diagnostician, and, among the less informed, has often led to the most serious errors of practice, by the employment of harsh means when the most mild and soothing alone were necessary. The signs of distinction are the following :—1. In fracture the shortening is real, and can be effaced only by extension and counterextension ; in sprains and contusions, on the contrary, it is not real, but feigned, as may be proved by placing the limbs parallel with each other, and

bringing the two iliac crests on the same level. 2. In fracture the eversion of the foot is complete, the extremity presenting an appearance characteristic of total loss of power ; in ordinary injuries of the hip and upper part of the thigh the eversion is comparatively slight, and the patient can generally rectify it by his own efforts, although they may be productive of severe distress. 3. In fracture there is usually complete abolition of muscular action ; so that the thigh can neither be flexed, extended, nor rotated, however determined the attempt. It is only in the impacted fracture that the individual has still some control over the limb, and then the best guide for avoiding mistake is the existence of actual shortening. In sprains and contusions motion is diminished, perhaps very greatly, but not abolished.

A very unpleasant consequence of sprains and contusions of the hip-joint is shortening of the thigh from interstitial absorption of the neck of the femur. Hence the patient, on recovering from the immediate effects of the injury, finding that the limb is permanently disabled, might accuse his attendant of ignorance. In order to guard against such a charge, it is well for the surgeon to inform the patient, at an early period of the treatment, of the possibility of such a contingency.

It might be supposed, at first sight, that it would be very difficult, even for an inexperienced practitioner, to mistake a fracture of the neck of the thigh-bone for a dislocation of its head upon the dorsal surface of the ilium, yet numerous cases are upon record testifying not only to the possibility of such an accident, but to its actual occurrence in the hands of the most distinguished surgeons. The only way to avoid error is to remember clearly the most prominent signs of each lesion. The subjoined tabular arrangement will serve to place the subject in its proper light, at the same time that it renders a comparison of these symptoms an easy task :—

Intracapsular Fracture.	Iliac Dislocation.
1. Occurs nearly always in old persons.	1. Is most common in adult and middle life.
2. Is most common in women.	2. Occurs with equal frequency in both sexes.
3. Usually the result of slight causes.	3. Always produced by severe force.
4. The foot is strongly everted.	4. The foot is inverted.
5. There is great shortening, readily effaceable by extension and counterextension, but recurring the moment the force is discontinued.	5. The shortening is also great, and can be effaced only by restoring the bone to its natural position, when it will not return.
6. Marked crepitation exists.	6. There is no crepitation.
7. There is preternatural mobility, the ends of the fragments being movable upon each other.	7. The bone is in a fixed and constrained position.

But the greatest difficulty in the diagnosis of these affections of the thigh and hip arises from the embarrassment which the surgeon experiences in determining whether the case is one of intracapsular fracture, or fracture exterior to the capsular ligament. As the subject is one of great practical consequence, it deserves to be studied with unusual care, and I shall, therefore, arrange the principal points in tabular form :—

Intracapsular Fracture.	Extracapsular Fracture.
1. The result commonly of slight injury, often indirect.	1. Usually caused by direct and severe injury.
2. The shortening, slight at first, generally not exceeding a third or half an inch, gradually increases to two inches and upwards.	2. The shortening is as great immediately after the accident as it is at any time afterwards, and its extent also is usually less than in the intracapsular fracture.
3. The crepitation is indistinct, and can only be fully elicited by extension and counterextension.	3. Crepitation is uncommonly distinct, being often loud and ringing, and is readily perceived on laying the hand on the trochanter and rotating the limb.
4. Function is much impaired, but often, at first, not wholly abolished.	4. The loss of power is complete, the limb lying in a helpless, paralyzed condition.
5. The great trochanter, on rotating the limb, moves, as it were, upon a pivot.	5. The great trochanter is often partially separated from the shaft of the bone, and then but imperfectly obeys the movements of the limb.
6. The pain is unreliable, both as it respects site and intensity, being generally most severe at the upper and inner part of the thigh, in the direction of the small trochanter.	6. The pain is usually very severe, especially on manipulation or motion, and seated more in the direction of the great trochanter.
7. There is generally little or no contusion, swelling, or discoloration.	7. Usually severe contusion, with considerable swelling, ecchymosis, and discoloration.

Nothing of any diagnostic value can be deduced from a consideration of the age at which these two fractures occur, since, as was previously stated, both are met with almost

exclusively after the fiftieth year, there being only a few well-authenticated cases on record of its occurrence prior to that period. The same is true in relation to sex, experience having shown that this exercises much less influence upon the production of these two varieties of fracture than was formerly imagined. I am inclined, from a careful study of the subject, to place more reliance, in this respect, upon the existence of severe external injury, as contusion, swelling, and ecchymosis, and upon the presence of shortening, than upon any other phenomena. In the intracapsular fracture, the external signs of injury are, certainly, as a general rule, exceedingly slight, while the reverse is usually the case in the extracapsular, the parts being nearly always much bruised and discolored. In regard to shortening, it possesses, I think, great value as a diagnostic of the two lesions; for it may be assumed, on the one hand, that when it is very slight immediately after the receipt of the injury, and gradually increases afterwards, it depends upon intracapsular fracture; and, on the other, that when it is very considerable immediately after the accident, it is caused by extracapsular fracture. Rodet, who studied the subject with much attention, arrived at the conclusion that every fracture of the neck of the femur, produced by a fall or blow upon the great trochanter, was of an extracapsular nature; whereas every one occasioned by a fall upon the feet, or by muscular action, must be seated within the ligament. This conclusion, however, is altogether unfounded; in adopting it, we should be compelled to assume that all intracapsular fractures are the result of falls upon the feet, when all experience teaches that they are almost invariably produced by force applied directly to the hip.

The most important diagnostic characters of the impacted fracture of the neck of the femur, whether within or without the capsule, are, as has already been stated, shortening of the limb, the absence of crepitation, and the comparative or complete immobility of the fragments. The shortening is always immediate, and remains permanent in its original degree, unless the ends of the bone are rudely drawn asunder; hence it is a sign of an unequivocal character; the absence of crepitation is also very significant, and the trivial mobility, or complete absence of motion, is another circumstance of importance. The great danger in such a case is that the fracture may be mistaken for a dislocation; but from this it may usually be readily distinguished by a careful study of its history, and a thorough examination and comparison of the symptoms characteristic of the two lesions.

FRACTURES OF THE GREAT TROCHANTER.

Fracture of this bony apophysis may take place as an independent lesion, or as a concomitant of fracture of the neck of the femur, outside of the capsular ligament, as mentioned previously, and as exhibited in fig. 593, from a specimen in my collection. As an independent fracture, it is very infrequent in comparison with the other variety. It may occur at any period of life, but is chiefly observed in elderly subjects, as a consequence of direct violence, as a fall, blow, or kick, breaking off the trochanter in an oblique direction from above downwards. The fracture is sometimes comminuted, the trochanter being broken into several pieces, of irregular size and shape, the fragments grating under the fingers like so many pieces of china. It may also be compound, although, in general, it is unaccompanied by any wound of the soft parts.

Fig. 593.

Fracture of the Great Trochanter.

The *symptoms* of this fracture are generally well marked, the most important consisting of eversion of the limb, with separation of the fragments, inability to sit down, and difficulty of obtaining crepitation. The eversion is unusually distinct, and is probably due, at least in great degree, to the loss of power in the external rotator muscles; the limb lies in a helpless condition, and no effort that the patient can make can change its position. The broken trochanter is commonly widely separated from the shaft of the bone, and hence the difficulty which is generally experienced in eliciting crepitation, this being only practicable by placing the parts in apposition with each other. The displacement is either upwards towards the ilium, or downwards towards the tuberosity of the ischium, the former being the more frequent. If the patient attempt to sit down he is completely foiled, and immediately

experiences great increase of pain, compelling him to desist. Most authors speak of shortening of the limb as a symptom of this fracture, but, if shortening really exist, it can only be in a very slight degree. More or less contusion and ecchymosis of the soft parts are usually present.

The diagnostic signs are the eversion of the limb, the loss of prominence at the natural site of the trochanter, the fixed position of the small fragment on moving the shaft of the femur, and crepitation on approximation of the broken ends.

The union is by osseous matter, and, unless the bone is comminuted, a cure may reasonably be expected without any deformity of the hip or impairment of the functions of the limb. Considerable difficulty, however, is generally experienced in maintaining apposition of the fragments, and hence such an injury always requires more than ordinary vigilance on the part of the attendant.

The *treatment* consists in maintaining the limb in a perfect state of quietude by means of two long splints, the foot being supported in a perpendicular direction, with a slight tendency to eversion, which is the most natural position for a person when he lies on his back, and, therefore, the most eligible for relaxing the external rotator muscles when there is a fracture of the trochanter. The broken trochanter, being drawn into its natural situation, is confined there by a soft leather belt, long enough to extend around the pelvis, and furnished with a hollow pad, from three to four inches in diameter, for the purpose of embracing more effectually the prominence of the hip. Hardly any extension will be necessary. If the soft parts are much contused, leeches and fomentations should be applied before putting on the permanent dressings. After the patient has been confined for a month, he may be permitted to exercise on crutches. The annexed cut, fig. 594, represents an excellent mode of treating fractures of the great trochanter recommended by Sir Astley Cooper.

Fig. 594.
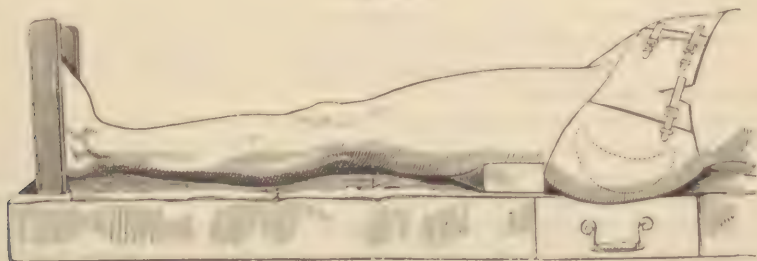
Sir Astley Cooper's Method of Treating Fractures of the Great Trochanter.

The great trochanter is occasionally detached from the neck and shaft of the femur, by the forcible laceration of the fibro-cartilage by which it is connected to these parts during early life, constituting what is known as the *epiphyseal* fracture, fig. 595, from Bryant. The union between these two parts is seldom completed before the twentieth year. The accident, which is very uncommon, is usually produced by a severe fall upon the hip, and is always extremely difficult of diagnosis, owing to the fact that there is seldom much, if any, appreciable displacement. In most of the recorded cases there was much diversity in the symptoms; in some the patient was able to walk immediately after the accident, while in others he had lost all control over the muscles of his limb; in some the foot was everted, while in others it preserved its natural position, or was even inverted; in all there was severe pain, with considerable swelling, either alone or conjoined with ecchymosis, at the site of injury, and, during their progress, more or less constitutional disturbance.

Fig. 595.

Epiphyseal Fracture of the Great Trochanter.

The best manner of determining the diagnosis, in this accident, is to make the patient lie on his back and incline the pelvis over the injured side, while the affected limb is thoroughly abducted, or carried away from the sound one. The gluteo-femoral muscles being thus completely relaxed, the trochanter, if detached, may easily be pushed into its natural position, and crepitation elicited by rubbing it against the neck and shaft of the femur.

The occurrence of this accident is not without danger, several cases having been recorded in which it proved fatal from extensive suppuration and constitutional disturbance.
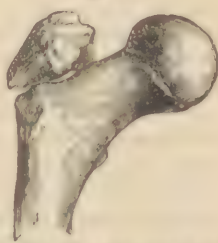
When recovery takes place, the limb remains long weak and painful. The union, under such circumstances, is fibro-cartilaginous, or partly cartilaginous and partly osseous. The treatment must be conducted upon the same principles as in ordinary fracture of the trochanter. A very instructive case of this accident, in a lad sixteen years old, caused by a sprain, and eventuating in death from periostitis and pyemia, was reported in 1875, by Professor Roddick, of Montreal.

FRACTURES OF THE THIGH IN CHILDREN.

Fractures of the femur sometimes occur in very young children, and are always peculiarly troublesome. The bone generally gives way at its shaft, as the result of external violence, and the symptoms are characteristic. Diastasis of the femur is extremely uncommon. It is most frequently met with in the lower extremity of the bone; separation of the head is an occasional occurrence, and epiphyseal fracture of the great trochanter is also a possible accident at a very early age. In a case of diastasis of the head of the femur in a stout, fat, healthy girl, twelve years of age, the accident was produced by a fall on the hip, from a low hand wagon. The case was at first treated as one of dislocation. After the lapse of four months, during part of which the limb was kept in a state of rigid extension, there was shortening of scarcely half an inch, and the thigh could be moved in every direction. Unfortunately there are no symptoms by which diastasis of the head of this bone can be distinguished from ordinary fracture of the neck.

Fractures of the thigh-bone are much more frequent in children than is generally supposed. Coulon states that in one year 140 cases were admitted into the St. Eugenia Hospital at Paris. Of these, 26 affected the femur. This bone is occasionally broken during delivery. The youngest case that I have ever met with was an infant four weeks old, in whom the accident was caused by a child rolling over its thigh as it lay in bed.

The obliquity in fractures of the thigh in children is generally considerably less than in adults, and cases are met with in which they are nearly transverse. Hence the tendency to overlap is usually comparatively slight, although in some cases it amounts to several inches. A species of green-stick fracture is occasionally witnessed, similar to that of the bones of the forearm.

In infants at the breast the treatment of this class of injuries is always attended with peculiar embarrassment and annoyance, owing, first, to the remarkable tendency to displacement of the fragments, and, secondly, to the constant liability of the dressings to be soiled by the discharges. To meet the first of these contingencies, the limb, after the subsidence of the inflammation and swelling, should be enveloped in a plaster of Paris bandage, and incased in two very light splints, either of wood, gutta-percha, or binder's board, the outer one reaching from a short distance below the level of the foot to the crest of the ilium or even to the chest. Layers of wadding should be applied to ward off pressure, when the splints should be secured with adhesive plaster, and covered with a roller. A little additional support is generally necessary in front of the thigh. Soiling of the dressings is best obviated by a thick coating of gum-shellac, paraffin, or coachmaker's varnish, frequently renewed. The object of the long splint is to keep up a certain degree of extension, and to prevent the child from flexing the pelvis upon the thigh. It is very important that the limb should be frequently examined, otherwise it may become shortened and crooked. The consolidation will be completed in from fifteen to twenty days.

In children from five to ten years old I have usually found the most convenient and suitable apparatus to be a case made of stout, unoiled sole leather, long enough to extend from the groin to an inch and a half below the heel, and sufficiently wide to come well around the limb, especially the thigh. It is supplied with a foot-piece of the same material, and is well padded at its upper extremity, to prevent undue pressure upon the perineum. The outside portion of the trough is continued for some distance over the hip, to which it is secured by a spica, or common roller, carried around the thighs and pelvis. A splint, also of leather, binder's board, gutta-percha, thin wood, or plaster of Paris, is stretched along the forepart of the limb from the groin to the patella, wadding being suitably interposed to ward off pressure; the apparatus is held in place by means of an ordinary bandage, adhesive strips having previously been secured to the leg and attached to the foot-piece. The dressing is completed by placing the limb, with its apparatus, in an easy position upon a hair or cotton bolster, gradually tapering upwards, its thickness below not exceeding four inches. By this simple contrivance I have always found it easy to obtain the requisite extension and counterextension, the

perineum affording a point d'appui which effectually prevents the ascent of the apparatus, while the foot-piece serves to keep the foot in place, at the same time that it receives the extending bands.

When the patient is very restive, it may be necessary to employ long splints, connected below by a cross-piece crutched-shaped above, and provided with a foot-board, stretched along each side of the body, to which, as well as to each limb, they are attached by appropriate belts or straps, so as to render the lower extremities perfectly immovable.   The belt that passes around the pelvis must have an opening in it for the easy evacuation of the bowels.   The plaster dressing, if properly applied, may be very serviceable in the treatment of fractures of children, notwithstanding what has been said to the contrary.   A splint made of this material, and closely fitted to the limb, forms an excellent support in fractures of the femur, when there is little or no tendency to displacement. Even when this tendency exists in a marked degree, the necessary extension can generally be readily made with the aid of such an apparatus, provided it be prolonged a few inches below the level of the sole of the foot, the adhesive strips being attached to the sides of the splint.

In diastasis of the head of the bone, osseous union should, I think, always be looked for, if the case be judiciously managed.   One important element in the treatment of such an injury obviously is compression, by suitable apparatus, of the hip, the more effectually to prevent displacement.   The extension should be steadily maintained for at least six weeks, and the trunk kept as quietly as possible.   Passive motion should not be instituted under two months.

CHAPTER IX.

DISEASES AND INJURIES OF THE JOINTS.

SECT. I.—WOUNDS.

The joints are liable to be laid open in various ways—by cuts, stabs, punctures, balls, machinery, and other means—and hence such lesions are said to be incised, punctured, gunshot, contused, or lacerated, according to the nature of the vulnerating body.   In extent they may be small or large; in character, simple or complicated; in effect, trivial or severe.

The symptoms are generally sufficiently distinct.   When any of the large joints are opened, whether by a cut, laceration, or bullet, the nature of the accident is ordinarily denoted by an immediate escape of synovial fluid, rapidly followed by great pain, tension, and swelling of the part, with severe constitutional disturbance.   When the wound is very large, especially if it is of a gunshot nature, there will generally be, along with these symptoms, violent shock, the patient being deadly pale, faint, sick at the stomach, and slow in reaction.   In from twelve to twenty-four hours after the accident, fever commonly sets in, often preceded by rigors, and soon succeeded by delirium, great gastric distress, intense thirst, and excessive restlessness, with a strong, full, bounding pulse.   The local phenomena assume a more aggravated character.   The heat, pain, redness, and swelling increase in intensity; the surface of the limb, at the seat of the injury, often assumes an erysipelatous aspect, sometimes as early as the first twenty-four hours after the accident, and the discharge of synovial fluid steadily augments in quantity, as well as in consistence, exhibiting a thick, ropy, turbid appearance; or, if the wound is closed, and the fluid is retained, the joint becomes distended in every direction, but particularly in its more dilatable parts, the skin pits on pressure, and distinct fluctuation is perceived. The secretion now takes on a puriform character; the patient has frequent rigors, alternating with flushes of heat, and followed by copious sweats; the joint is exceedingly tense; the synovial membrane is universally involved; perforative ulcers form at different points; matter, often of a highly fetid nature, is freely discharged; the bones are rendered carious; and the ligaments, softened and thickened, yield at various points of their extent. In many cases matter forms exterior to the joint, and is extensively diffused among the muscles and through the subcutaneous connective tissue.

But it is not always that the affection progresses in this rapid and untoward manner.

In many instances, depending mainly upon the nature and extent of the lesion, and the character of the treatment, the inflammation, after having persisted for a few days, gradually disappears, and the patient recovers with hardly an unpleasant symptom, the joint, it is true, remaining temporarily stiff, but ultimately completely regaining its functions.

All lesions of this kind, however, should be regarded with suspicion; for, if they are not dangerous in the first instance, they are exceedingly liable to become so during their progress, and this is true of the most trivial wound as well as the most extensive. Sometimes a fortunate recovery occurs in cases, apparently, of the most desperate character. Thus, I attended a lad, fourteen years of age, who, while bathing, struck his knee against the sharp point of a rock, causing a severe penetrating wound, which healed without any serious local or constitutional symptoms, although it was at first in all respects most unpromising. In another instance, the knee-joint was opened by a pistol ball, entering by the side of the patella, and permanently lodging in one of the condyles of the femur, with no other effect than that of a moderate synovitis, and slight lameness.

Simple incised wounds are generally less to be dreaded than lacerated and gunshot, although undoubtedly many cases occur where the symptoms are extremely severe, and where the risk to limb and life is very great. It may also be assumed that wounds of a small joint are less dangerous than similar injuries of a large joint, incised than lacerated, small than large, and simple than complicated; the lesions, in these respects, being governed by the same laws as wounds in other parts of the body. There are several circumstances, however, which render wounds of the joints, especially the more important ones, as those of the knee, ankle, and elbow, peculiarly perilous, and which are the more to be dreaded because they are of frequent occurrence. These are erysipelas, pyemia, and tetanus.

Erysipelas, as a consequence of articular wounds, usually sets in within the first thirty-six hours, beginning at the site of injury, and spreading thence gradually over the neighboring surface. Its precise type will depend materially upon the state of the system at the time of the accident; its symptoms exhibit nothing peculiar, but its progress is often very rapid, and its presence is always denotive of a bad state of the constitution, which it is frequently difficult to counteract by remedies.

Pyemia and septicemia are frequent results of wounds of the larger joints, especially when of a lacerated, contused, or gunshot nature. Abscesses of the internal organs, as a consequence of pyemia, were occasionally noticed by some of the older surgeons. The viscera which are most liable to suffer are the lungs, liver, spleen, and kidneys, the disease usually appearing within the first five or six days, and speedily undermining the constitution. Large accumulations of pus occasionally take place in various parts of the connective tissue and in the splanchnic cavities, particularly the thoracic. As a concomitant of this occurrence, important changes take place in the local symptoms. The pain becomes extremely intense, the swelling rapidly increases, and the wound discharges an abundant fluid, of a thin, sanious, and highly fetid character, denotive of the bad nature of the inflammation. The general phenomena are typhoid, the patient is delirious, and death soon closes the scene.

Tetanus is an occasional occurrence after injuries of this kind, but not so frequent a one, perhaps, as is generally supposed. It usually comes on within the first week after the accident, and often terminates fatally in three or four days, few persons recovering from its effects. The occurrence is much more common in military than in civil practice.

The hemorrhage attendant upon wounds of the joints, although generally trivial, is occasionally very profuse, not always so much from lesion of the articular vessels themselves as from injury sustained by those in the immediate vicinity. When from any cause the blood accumulates in the articulation, it will be very apt to act as an extraneous substance, undergoing decomposition, and thus greatly aggravating the case.

Although injuries of this kind are generally attended with an escape of synovial fluid, there are cases, as when the wound is very long and narrow or valvular in its shape, in which there is no such appearance. Moreover, it must not be forgotten that in fat subjects wounds over a joint may furnish a fluid which closely resembles the synovial, but differs from it in being destitute of the oleaginous feel, which distinguishes the latter when rubbed between the fingers.

Treatment.—The treatment of these wounds is sufficiently simple, inasmuch as it involves no principles different from those which guide the surgeon in the management of similar lesions in other regions of the body. It consists, mainly, in removing extraneous

matter, approximating the edges of the incision, excluding the admission of air, forbidding all motion of the joint, and employing antiphlogistics to their fullest extent.

In a simple incised wound, a few strips of adhesive plaster generally suffice to effect approximation, and the risk of admitting air will be greatly diminished, if the part be covered with a compress wet with blood, and bound down by a roller, extending from the distal portion of the limb. Collodion, applied upon strips of patent lint, often makes an excellent dressing. If the wound is large, a few sutures may be necessary, carried, of course, merely through the common integument. When the wound is very ragged, the edges should be carefully pared, to place them in a better condition for immediate reunion. No air must be allowed to enter the joint, lest it cause decomposition of the inflammatory products.

When the wound is large, the synovial membrane may be covered with extraneous matter, as dirt, sand, or other substance, which may not only prove difficult of removal, but will be sure to enhance the danger of erysipelas, pyæmia, and tetanus. Clearance must be thorough, and the finger and forceps will be the best instruments for effecting it. Any clotted blood that may exist must be similarly dealt with. If the foreign matter is deeply imbedded in the joint, and the wound is disproportionately small, rendering a search for it difficult and uncertain, the safest plan will be to let it alone. Balls ought certainly always to be treated in this manner. If, on the contrary, the projectile lie loose in the articulation, it should unquestionably be extracted at once, and so with every other movable or floating body, provided it is readily accessible, or that it can be taken away without the risk of inflicting serious additional injury. All officious interference, by finger, probe, or other instruments, must be scrupulously avoided, as the synovial membrane is exceedingly intolerant and resentful of manipulation, however gently conducted.

Needles imbedded in a joint should be extracted without delay, and at all hazard, otherwise the most serious effects, as violent inflammation, suppuration, and ankylosis, will be sure to arise. The proper plan is to make a sufficiently large incision to obtain ready access to the foreign body without the risk of bruising and irritating the soft structures, the wound being immediately made air-tight by suture and collodion, and the limb placed upon a suitable splint, with the muscles in an easy, relaxed position. Morphia and quinine should be freely administered, and the joint enveloped in pounded ice, to prevent undue reaction.

When there is no prospect of union by the first intention, or when the condition of the wounded joint is such as to render suppuration inevitable, the proper plan is to draw the edges of the gap lightly together with adhesive strips, and to employ at once medicated applications, as lotions of acetate of lead and opium, or emollient cataplasms.

The joint is maintained in an easy, elevated, and relaxed position, all motion being guarded against by the use of splints and other suitable means. If the inflammation run high, and the patient is young and plethoric, blood is drawn from the arm, or, at all events, by leeches from the affected parts, the bowels are thoroughly moved, and the heart's action is controlled by depressants. Morphia, in large quantity, will be required to relieve pain and spasm ; and there is hardly a case, certainly no severe one, where it will not be proper to combine calomel with the anodyne, with a view to its speedy effects upon the system. The acknowledged efficacy of mercury in all inflammations of the serous textures clearly points to its administration as a matter of paramount importance here. It not only exerts a most happy influence upon the capillary vessels of the diseased membrane, modifying and changing their action, but it is a powerful sorbefacient, causing the removal of effused fluids. Its effects, however, must be carefully watched, lest they exceed our intention, which is only to cause tenderness of the gums, not positive ptyalism. Along with these general measures, local remedies must be used, of which the most trustworthy are evaporating lotions, the early and energetic use of ice, and intermittent, digital compression of the main artery of the limb.

During the progress of the treatment, matter may form within the joint, and become pent up for the want of an adequate outlet. Under such circumstances, relief must be afforded by a valve-like aperture, the puncture being immediately closed by collodion, and afterwards reopened as occasion may demand. When the quantity of pus is very great, pressing upon the joint in every direction, a free, direct incision should be made to admit of full drainage. It has always appeared to me that surgeons are too timid in these cases, and that they do not sufficiently coöperate with nature in her efforts at relief. It is not necessary here to describe the pernicious consequences which purulent accumulations, especially if long retained, must inevitably exert upon the component elements of the articulation. They can be nothing short of utter ruin of the synovial membrane, car-

tilage, and bone. Early evacuation must also be effected, if matter form immediately around the joint, beneath the skin, and among the muscles.

When the discharge is profuse and offensive, injections of infusion of linseed, slightly medicated with the chlorides, will be of service; they should be thrown in tepid, several times in the twenty-four hours, and may occasionally be advantageously followed by the introduction of very weak solutions of iodine, or of nitrate of silver, with a view of modifying the action of the synovial membrane. Too much caution, however, cannot be used in the application of these remedies, as the inflamed membrane is often exquisitely sensitive, and intolerant of such interference.

Whenever there is extensive suppuration, the parts will either recover by ankylosis, or the cartilage and bone will become so involved in the disease as to require removal. In the former case, the joint should be placed in the best position for future convenience and usefulness; while in the latter the affected structures should either be excised, or the limb amputated. The choice of the operation must be regulated by circumstances. If the inflammation has measurably subsided, and the patient's strength is not too much exhausted, the joint may possibly bear excision; in all cases of an opposite character, removal of the limb will be the safer operation.

In the milder forms of wounds, unattended with risk to limb or life, the great point is to guard against ankylosis, which is so liable to occur even in the most trivial affections of the articulations. Passive motion, sorbefacient embrocations, and the gradual use of the limb, will be the surest means of success.

Primary amputation will be required when the joint is severely shattered, whether by gunshot or otherwise, and the external opening is unusually large, or complicated with lesion of the principal vessels and nerves of the limb. It may be assumed, as a rule, that gunshot wounds of the large articulations of the extremities are nearly always fatal if amputation is not speedily employed. The same is true, although in a more limited sense, of gunshot injuries of the joints of the toes and fingers, in which tetanus and other bad effects are prone to ensue. When, as occasionally happens, the articular surfaces are covered with foreign matter, which it is impossible to detach without injury to the synovial membrane, the safest plan will be to amputate the limb. Conservative surgery in such a case is decidedly bad surgery.

SECT. II.—CONCUSSION.

The joints, like other parts of the body, are liable to concussion, the effect of the forcible contact of their surfaces; and such accidents may occur in various degrees, from the slightest disturbance to the most violent commotion. Blows and falls, operating either directly upon the part or indirectly through some intermediate structure, are the most common causes of the occurrence. The force inflicting the injury is generally transmitted, as is exemplified when a person falls from a great height and alights upon his feet, where the force, instead of being expended upon the parts struck, is sent along the leg to the knee, and thence through the thigh to the hip, the latter, perhaps, receiving the main brunt of the blow. When the concussion is very severe, the joint may be more or less contused, and it may even be attended with fracture of the articular extremities of the bones. In such an accident, shock is conjoined with contre-coup. The joint, instead of transmitting the shock, is severely concussed, the force being concentrated upon its anatomical elements, the adjoining structures escaping with but little injury, although there may occasionally be slight laceration of some of the ligaments. The effect may be limited to one joint, or it may involve several, as when a person falls from a considerable height and alights upon his feet or knees. In this way excessive shock of the spinal column is often produced, every joint being violently shaken, at the same time that more or less of the force is transmitted to the spinal cord, its envelops and nerves, causing an amount of injury which, if not immediately fatal, is often followed by the most serious consequences. Concussion of a joint is occasionally produced by very slight causes. Thus, I have been several times consulted on account of severe pain and lameness of the fingers, produced by striking the keys of the piano; and there are few persons who have not experienced a similar effect in the toes, from knocking their extremities forcibly against a stone or some other hard, resisting body.

When a large joint is severely concussed, the symptoms will be those of ordinary shock, and some time may, therefore, elapse before the patient recovers from the immediate effects of the injury. In many cases, indeed, the parts continue to be weak, tender, and stiff for an indefinite period, if not during the remainder of life. A very singular, if not

unique, case of this kind, occurring in the hip-joint, was recently reported by Dr. W. H. Daly, of Pittsburgh, and affords a beautiful illustration of the nature of this class of affections. A very strong, muscular man, twenty-three years of age, in the act of jumping suddenly out of bed, while the foot was forcibly abducted, and the whole weight of the body thrown upon the corresponding side of the pelvis, tore away the round ligament from its acetabular attachments, and violently contused the head of the femur at its postero-superior circumference over a space of two inches in length by one inch in width. No signs of fracture or of dislocation existed, and, what was very remarkable, the man walked four miles the day after the accident, although not without severe pain. Violent inflammation ensued, followed by death from tetanus at the end of thirty-six days. The structures around the joint were greatly softened and infiltrated with bloody serum, while the articular cartilages at the points of injury were disintegrated, pulpified, and partially removed by ulcerative absorption. No pus was found, and the capsular ligament was intact. In subjects predisposed to scrofulous disease, a bad form of synovitis is apt to arise, followed eventually, if the parts do not receive proper attention, by complete disorganization of the injured joint. In gouty and rheumatic persons, a slow, chronic inflammation is not unfrequently set up, causing severe pain and difficulty of locomotion, and leading to serious alteration of structure, as ivory degeneration of the bones and cartilages and the development of exostoses around the articulation.

The *treatment* of this class of injuries is sufficiently obvious. The great point is to keep the parts perfectly at rest, in an immovable position, insured, if necessary, by appropriate splints. For the first few days the affected joint should be wrapped up in cloths wet with a strong solution of acetate of lead and opium ; or, if the injury has been unusually severe, surrounded with a bladder partially filled with pounded ice. Leeches may be required when there is danger of active inflammation. Anodynes are given to allay pain and spasm. After the primary effects of the injury have passed off, passive motion is instituted, the hot and cold douches applied, and free use made of liniments and embrocations, along with gentle exercise, care being taken for some time not to bear much weight upon the affected structures.

SECT. III.—SPRAINS.

A sprain is the wrenching of a joint in which its ligaments are severely stretched, if not partially torn, and more or less injury is done to the parts around. Falls, blows, and twists, attended with rotation of the articulating surfaces, or a movement of these surfaces in opposite directions, are the most common causes of the accident.

The joints most liable to sprains are the ginglymoid, or those which admit of motion principally in two directions, as the knee, ankle, and elbow. The articulations of the toes, thumb, and fingers frequently suffer for the same reason, their functions and exposed situation rendering them especially prone to such accidents. The reason why the orbicular joints are so seldom affected in this way is their greater latitude and freedom of motion, their surfaces being thus enabled to undergo extensive rotation without putting their ligaments or the surrounding parts materially upon the stretch, whereas in the hinge-like joints the most trivial twist, by opposing a sudden check to their extremities, must necessarily cause a severe wrench. Moreover, it must not be forgotten that there is an essential difference in the structure of the ligaments themselves in the two classes of joints, which cannot fail to exert a powerful influence upon the production of the accident in question. In the orbicular joints the connecting media are of a fibrous texture, comparatively thin, yielding, and extensible, and, therefore, able, to a considerable extent, to get out of the way of injury ; in the ginglymoid, on the contrary, the ligaments are exceedingly firm, short, and indisposed to stretch, or, when stretched, incapable of withstanding rupture of their fibres. The orbicular joints are, however, notwithstanding their greater latitude of motion and the more yielding nature of their ligaments, occasionally severely sprained in consequence of the extreme abduction of the limbs. Thus the ilio-femoral articulation is sometimes violently sprained by the sudden slipping of the foot outwards, far beyond the line of the body, so as to put both the capsular and round ligaments strongly upon the stretch, inducing symptoms extremely simulative of dislocation of the head of the bone into the thyroid notch.

It is probable that there is, in every case of severe sprain, more or less injury inflicted upon the parts in immediate relation with the affected joint. The muscles and tendons must necessarily participate in the wrench, sustaining partial displacement, and sometimes even slight laceration ; the nerves and vessels are stretched, and the skin is often bruised

and discolored, especially when the accident has been the result of external violence. In the latter case, the articulating surfaces, being violently brought together, not only experience severe shock, but a considerable degree of contusion, thus greatly aggravating the suffering. Now and then, indeed, small portions of cartilage, or even of bone, are chipped off or partially displaced, but still slightly adherent to the sprained ligament, constituting what is known as the *sprain-fracture*, particularly common in the ankle-joint.

The *symptoms* denotive of sprain are, the instantaneous occurrence of pain, referred to the affected joint, impairment, if not total loss, of motion, and a sense of faintness or sickness, caused by the shock of the system, which is sometimes extremely severe, even when no external injury has been sustained, the accident having been induced merely by a wrench or twist of the limb. If some time have elapsed since the accident, there will be swelling and tenderness of the integument, as well as of the deeper structures, and probably also an indistinct perception of crepitation, depending upon the deposit of plastic matter. Discoloration of the surface, from extravasation of blood, is also very common. The pain is often excessive, especially soon after the accident, and quite overpowering in its effects.

The only accidents with which a sprain is liable to be confounded are dislocation and fracture; from which, however, it may generally be readily distinguished by a careful manual examination, by the form of the joint, by a comparison of the length of the affected limb with that of the sound one, by the history of the cause of the lesion, and, lastly, by the fact that the patient is usually able to use the parts, at least to some extent, immediately after the receipt of the injury. In fracture the most reliable symptom is crepitation. The examination should always be most thorough, lest a luxation or fracture be ultimately found, perhaps when too late to effect reduction, where originally only a sprain was suspected.

When the sprain is slight, the pain gradually subsides, the swelling is resolved, and the joint soon regains its accustomed functions. It is far otherwise, however, when the injury is of an opposite character, or attended with severe wrenching of the ligaments, violent contusion of the articular surfaces, and considerable lesion of the surrounding parts. The suffering will then be proportionately great, inflammation will be apt to run high, convalescence will be tedious, and the joint may remain weak and tender for many months, if not for years. A severe sprain, in fact, is often a much more serious accident, as it respects its secondary effects, than a dislocation or a fracture near a joint. In neglected or ill-treated cases, and sometimes even when every possible precaution has been adopted, the articulation continues not only to be weak and uncomfortable for a long time, but the corresponding limb becomes cold, wasted, flabby, and exquisitely sensitive; perhaps also the seat of neuralgic pain, subject to severe exacerbation whenever exercise is attempted, or there is a change in the weather. Occasionally, indeed, the movements of the joint are permanently lost. Conjoined with this local trouble there is generally grave disorder of the general health, the patient being extremely nervous, irritable, and dyspeptic, fancying himself helpless and disqualified for all useful exertion, both of mind and body. The probable cause of all this suffering is the shock or concussion sustained by the nerves of the affected joint at the moment of the accident, the effect thus produced exercising a pernicious influence upon the nutritive functions of the whole limb, and indirectly upon the well-being of the general system, especially the great nervous and ganglionic centres.

Treatment.—The leading indications in every case of sprain, whether light or severe, are, first, to limit and combat inflammation, and, secondly, to restore the joint, if possible, to its wonted functions. The former is fulfilled by the judicious use of antiphlogistics; the latter, by sorbefacients, passive motion, and exercise in the open air.

As soon as the affected joint has been properly examined, the limb connected with it is carefully bandaged, and placed perfectly at rest in an easy, elevated, and relaxed position, splints, a wire case, or a wooden box being used, if necessary, to insure more certain quietude and support. Sometimes the object is readily attained by laying the limb simply upon a pillow, although in warm weather this will be objectionable, as tending to keep up too much heat. Fomentations will usually be found to be more agreeable and soothing than cold applications, especially during the first few days, in nervous, irritable subjects; and the one which I generally prefer is a strong solution of acetate of lead and opium in hot water, applied by means of a piece of flannel, arranged in three, four, or six layers, and covered with oiled silk, to confine the heat and moisture. Instead of removing the cloth whenever it becomes dry, the best plan is to squeeze the lotion upon it from a sponge, as this will obviate injurious motion and exposure to the atmosphere. Solutions of chloride

of ammonium and opium, a mixture of warm water, laudanum, and alcohol, and thin bags of hops, will also be found extremely soothing. Occasionally pounded ice, applied in a bladder, is more agreeable than any other local remedy, especially in young, plethoric subjects. In sprains of the ankle-joint, excellent effects frequently follow the protracted immersion of the limb in hot lye or hot salt water. When the pain and swelling are unusually severe, leeches will be necessary; and great benefit will then also accrue from the localized steam bath, applied twice a day for an hour at a time. Anodynes are given to allay muscular spasm. Purgatives must not be neglected; and constitutional excitement must be allayed in the usual manner. In short, the antiphlogistic system must be carried out in its fullest extent.

When warm applications disagree, or fail to give relief, they should be replaced by cold, consisting either simply of water, of ice, or of some refrigerating mixture. The proper rule, in all cases, is to continue no remedy longer than it is found to be soothing and beneficial. The bandage must be carefully watched; judiciously employed, its effects are usually highly advantageous, affording support to the injured joint and limb, preventing swelling and spasm, and promoting the absorption of effused fluids.

In the milder forms of sprains, more simple means will, of course, answer, such, for instance, as applications of the tincture of arnica, laudanum, or laudanum and spirit of camphor, together with perfect quietude of the affected parts. In cases of this description the immediate application of the immovable bandage affords almost instantaneous relief, and materially shortens the cure.

The urgent inflammatory symptoms having been thus dissipated, embrocations, liniments, or lotions will be of use, the object now being the removal of effused fluids and the gradual restoration of the functions of the joint. These should be applied at first once, and afterwards twice, a day with the bare hand, the friction being regularly increased as the pain and tenderness diminish, and it will be well generally to keep the parts wet with the medicine by means of a piece of flannel. Whatever local remedies be used, the bandage must on no account be neglected; for, beneficial as it may have been in the first instance, its effects will now be incomparably more so. The limb, weakened by the previous suffering, requires tone and support, and there is nothing so well adapted to promote this object as the careful and judicious employment of the roller. It should be renewed at least once a day. Sometimes the bandage may be advantageously replaced by adhesive strips, applied as in dressing indolent ulcers.

At a still later stage of the treatment, great benefit may be expected from the cold douche, the water being pumped upon the part, or poured from a considerable height, and the surface well rubbed afterwards with the bare hand, or a piece of coarse flannel. In some cases, where a more powerful impression is necessary, it will be found highly advantageous to precede the cold by the hot douche. Along with these means, the use of the bandage is still steadily continued, and it may even be necessary to persist in the employment of stimulating embrocations. In very obstinate cases I have occasionally derived marked benefit from the daily application of fish-brine, rubbed on well with the bare fingers. Sometimes a blister affords more relief than any other remedy, and now and then electricity is advantageous.

As soon as the disease has reached the chronic stage, the joint must be gently exercised, and the patient made to walk about upon crutches in the open air. As great care should always be taken, in the acute stage, not to move the parts too soon, so in this its employment must not be too long postponed. Motion is the proper stimulus of a joint, as air is of the lungs, or food of the stomach, and when, after any injury, it is long neglected, serious consequences will be sure to arise. By and by the crutch must be laid aside for the cane, and this in turn for the limb, the joint and muscles being gradually forced into action. In nervous, hysterical persons this will often be a sore trial, requiring no ordinary effort of the will; nevertheless, it must be done; there is no alternative; the parts must be used, or they will inevitably remain stiff and tender, and ultimately become worthless.

Massage is of great value sometimes even in cases of recent sprains, and when properly practised, is extremely beneficial, rapidly relieving pain and swelling, and promoting the restoration of the functions of the affected joint. It must, of course, not be employed too rudely at first, or repeated too frequently. One application a day, or even every other day, will be quite sufficient, if continued for fifteen to twenty minutes at a time.

When there is much constitutional suffering, as there often is in the more severe forms of sprains, alteratives and tonics will be needed, the most suitable being blue mass, quinine, iron, iodide of potassium, and bichloride of mercury. Exercise in the open air must not be neglected.

SECT. IV.—SYNOVITIS.

Inflammation of the joints, technically called synovitis, is liable to occur in all articulations, but more especially in the large and more important, and may be induced by various causes, both local and constitutional, as exposure to cold, the presence of interarticular bodies, and mechanical violence, as sprains, blows, falls, and contusions. In the great majority of cases, however, it arises from the effects of rheumatism, gout, eruptive fevers, syphilis, scrofula, and the inordinate use of mercury.

The *symptoms* characterizing inflammation of the synovial membrane are, stiffness of the corresponding joint, usually greatest in the morning immediately after rising, but gradually diminishing upon exercise ; pain and tenderness on moving and percussing the limb ; swelling and fluctuation of the affected part ; a pale, glossy appearance of the skin ; inability to maintain the extended position ; and a sense of heat within the articulation. As the disease progresses the symptoms increase in severity, and the system, sympathizing with the local disorder, is thrown into violent commotion, there being high fever, a full, bounding pulse, and an arid state of the skin, with excessive thirst, and all the other phenomena of inflammatory excitement. In this condition the pain is generally very excruciating, especially at some particular spot, depriving the patient completely of appetite and sleep, and requiring opiates in large doses for its relief.

The disease, however induced, frequently comes on in a slow, gradual, and insidious manner, even when caused by external injury, being characterized, perhaps, merely by a trifling enlargement of the joint, arising from an increase of synovial fluid within its cavity, or partly from this and partly from inflammatory deposits in the surrounding structures, attended with some degree of tenderness on pressure, and more or less suffering on motion of the affected parts. Eventually, however, yet it may not be under several weeks, or even months, the joint assumes a soft and really swollen appearance, as in fig. 596, the limb becomes wasted, the functions of the articulation are materially impaired, and all the symptoms are aggravated.

Fig. 596.

Acute Synovitis of the Right Knee.

In rheumatic synovitis the symptoms are usually bold and well marked from the start. The attack often comes on in the following manner. The patient, having been exposed to cold, or been guilty of some excess in eating or drinking, retires at night with some degree of soreness in his joints, commonly attended with a general feeling of uneasiness, and wakes up in the morning with excessive pain, great tenderness on pressure of the affected parts, with considerable discoloration of the surface, and, probably, utter inability to use his limb. He is feverish and uncomfortable ; his pulse is strong and full ; the skin is hot and dry ; the bowels are costive ; and the urine is scanty, high-colored, and loaded with urates. The joints become gradually more deeply involved ; all the local symptoms increase in violence ; an abundance of synovial fluid is effused ; and, if the inflammation is not speedily arrested, suppuration will probably take place, the event being preceded and accompanied by rigors and high constitutional excitement. The joints most liable to suffer from rheumatic synovitis are the knee, ankle, wrist, and elbow, those of the hip and shoulder being seldom involved. The articulations of the fingers also frequently suffer, and that of the great toe rarely escapes when the disease in the other joints is at all severe. The inflammation often begins simultaneously in several joints ; or, if it commence in one, it is extremely apt to involve others in its progress, especially its fellow of the opposite side. Thus, articular gout or rheumatism of one knee nearly always attacks the other knee before it finally ceases.

In chronic articular rheumatism, calculous concretions are liable to form, especially in the joints of the fingers, where they always prove a source of great inconvenience and suffering. Their character will be specially considered under the head of interarticular bodies.

Syphilitic synovitis belongs to the tertiary form of syphilitic disease, and seldom makes its appearance until several years after the primary affection. It is most frequently met with in persons whose health has become exhausted by profuse courses of mercury and habitual intemperance. The larger articulations, especially those of the knee and elbow, are its most common seat ; but the smaller ones, as those of the fingers,

are by no means exempt from it. A good deal of effusion of synovial fluid usually attends; the joint, in consequence, is swollen and fluctuating, motion is impeded, the parts are tender on pressure, and the patient is harassed by excessive pain, which is always worse at night, after he becomes warm in bed. This latter circumstance, together with the history of the case, and the coexistence of syphilis in other structures, will always suffice to determine the diagnosis.

Of strumous synovitis particular mention will be made under a separate head; meanwhile, it is only necessary to state that the disease is almost peculiar to childhood, that it most commonly attacks the hip, knee, or elbow, and that it occurs only in persons of a strumous predisposition.

Suppuration, as a consequence of ordinary synovitis, is unusual. Arthritic inflammation of the joints also rarely terminates in the formation of pus, and a similar remark is applicable to articular syphilis; in scrofulous affections of the joints, on the contrary, suppuration is extremely common, and constitutes one of the great dangers of the disease.

The phenomena which announce the formation of matter are usually unequivocal. After the disease has continued for some time, violent rigors set in, followed by high constitutional reaction and copious sweats, the patient being delirious, excessively restless, and tormented with thirst. All the local symptoms are greatly aggravated, as is shown by the severity of the pain, the rapid increase of the swelling, the extraordinary heat, and the deep discoloration of the skin. If the pus is not speedily evacuated, hectic irritation supervenes, the appetite declines, the sleep is interrupted, the surface is drenched with perspiration, colliquative diarrhœa sets in, and death gradually closes the scene. This, however, is not constantly the course pursued by the disease. In many cases ulceration takes place, and the matter, thus finding vent, ceases to commit further ravages, although generally not until the cartilaginous and osseous tissues have become deeply involved in the mischief, and the patient, consequently, is doomed to carry out a miserable existence, with a stiff joint and a deformed limb, or to perish from the remote effects of the disease, after many months, if, indeed, not several years, of great suffering.

A joint that has once been inflamed from any cause whatever, remains long weak, and predisposed to disease, the most trivial circumstance tending to induce relapse, and to reawaken the symptoms in all their primitive severity. A frequent repetition of the morbid action must necessarily, by degrees, lead to disorganization of the component structures of the joint and to more or less extensive adhesions between the contiguous surfaces, eventually followed by complete loss of function.

The *pathological* changes which characterize this affection must necessarily vary a good deal, according to the nature of the exciting cause, and the duration of the morbid action. In the earlier stages of the disease there ordinarily is merely some degree of vascularity, along with slight opacity of the affected membrane, and some increase of the natural secretion. Here and there a little plastic matter is perceptible, either adherent to the inflamed surface, or floating about in the midst of the synovial fluid, which is usually, at the same time, more or less turbid, and abnormally thick and viscid. At a subsequent period, and especially in the more severe forms of the disease, these morbid appearances exist in a still higher degree. There is a greater amount of lymph, the vascularity is more intense, as well as more diffused, and the synovial secretion is of a dirty, glutinous nature. In some instances pus is freely poured out, and lining membrane, cartilage, and bone are all involved in the ruinous consequences. In the worst cases, the purulent fluid, exciting perforative ulceration, escapes from the joint, the passages afterwards remaining fistulous. The surrounding structures are thickened by plastic deposits, softened, or softened at some points and indurated at others, and unnaturally red and congested.

Treatment.—When the disease is one of ordinary character, depending upon traumatic causes, or ordinary constitutional derangement, as a depraved condition of the secretions, or upon suppression of the cutaneous perspiration, it will generally be found to yield to the judicious application of the more common antiphlogistic measures, such as would be indicated in common inflammation of other parts of the body. If the symptoms are at all urgent, and the patient is young and robust, blood must be freely taken from the arm, and the bowels opened with an active cathartic, followed by antimonial and saline preparations, with the addition of a sufficiency of morphia to promote perspiration, allay pain, and induce sleep. Mercury is administered when there is danger of structural lesion, or evidence of plastic effusion, and is carried to the extent of rapid but gentle ptyalism, with the hope of saving texture and preventing adhesion. The diet is light and spare; the drink cooling and acidulated.

As it respects the local means, the joint is placed in an easy, elevated, and relaxed position, over a pillow or bolster, the limb being put up, if necessary, in splints, or other suitable apparatus, for the purpose of more certainly insuring quietude. The rest must be absolute and unconditional. If the affected surfaces are permitted to rub against each other, even in the slightest degree, the effect must inevitably be to aggravate and protract the morbid action.

Of direct topical applications the most important are leeches and fomentations. Leeches, however, are, as a general rule, only necessary in the more urgent cases, attended with great pain, heat, and swelling, and then they should be employed freely, in such numbers and in such a manner as the violence of the disease and the condition of the system may seem to indicate. Cupping is not to be thought of in inflamed joints, as the percussion attending the operation causes more injury than benefit. In young and otherwise healthy subjects, especially in hot weather, cold applications, medicated freely with laudanum, are sometimes exceedingly grateful and beneficial, promoting evaporation, allaying pain, and opposing swelling; but, in general, warmth combined with moisture will be found to be most soothing and agreeable. The best plan, however, always is to consult the feelings of the patient, or to change the applications whenever they cease to be beneficial. When these means fail, or when the disease is making rapid progress, there is no remedy so capable of affording relief as a blister, large enough to cover in the whole joint, well sprinkled with morphia, and retained until it has produced thorough vesication, the parts being dressed afterwards with a light, emollient poultice or with cloths wrung out of warm water, with a piece of oiled silk over the surface to confine heat and moisture. Cantharidal collodion is generally preferable, as a vesicant, to the common blister, as the latter is often adapted with difficulty to the shape of the affected joint.

If matter form, it is to be dealt with in the same manner as in other parts of the body. It is folly to look upon it in any other light. It is pent up, and, as it is not amenable to the action of the absorbents, it must be evacuated as early as possible, before it has caused any serious structural evil. The employment of the aspirator generally affords excellent results, except when the matter is unusually thick, when an incision must be made, not, of course, direct or large, but subcutaneous and small, the orifice being immediately closed to prevent the admission of air. A timid, cautious course does not answer here; so long as the pus is confined it must keep up pain, and injure the structures with which it lies in contact; impairing and ultimately destroying their vitality, and thus putting both limb and life in imminent peril. The opening should always be made at a dependent part, and be repeated from time to time until the matter ceases to accumulate, the joint being well supported in the interval by a bandage, or by a roller and adhesive strips. In some cases the joint may be so completely distended with pus as to demand imperatively a free direct incision for its relief; a course of treatment upon the importance of which I have strenuously insisted for more than a third of a century in my annual courses of lectures. When ulcerative perforation has taken place, free drainage must be established, and it is in such cases that the seton passed through the joint, as recommended by Sayre, may occasionally be advantageous. In any event, antiseptic dressings must be employed.

The surgeon need not always despair of effecting a good cure even after suppuration has taken place, if the above measures are cautiously carried out; the joint will probably be stiff, but it should be recollected that an ankylosed joint is always better than no joint at all, provided it is put in a proper position for future usefulness.

When the disease has passed into the chronic stage, the main reliance must be upon the steady, persistent use of the bandage, the douche, stimulating lotions, and friction. The joint is showered twice a day, first with hot, and immediately after with cold water, when, being dried, it is thoroughly rubbed with some embrocation, or mild mercurial ointment, or painted with a weak solution of iodine, and put up in a roller, extending from the distal portion of the limb. Passive motion is instituted, and steadily continued so as to make gentle and equable friction upon every part, until there is complete restoration of the functions of the joint. Gentle exercise must be taken upon crutches in the open air; and for a good while the limb must not be permitted to sustain the full weight of the body. In some cases the joint may be advantageously strapped with ammoniac and mercurial plaster, or a plaster composed of opium and galbanum, to promote the absorption of effused fluids, and lend support to the weakened structures. Compression with a wet sponge is also a most valuable remedy in such an event. If the case prove obstinate, the fluid may be removed by aspiration, and the joint be subsequently strapped,

when the remaining symptoms may be scattered by the use of iodide of potassium with a minute quantity of bichloride of mercury, given three times a day, and pushed to gentle ptyalism. When ankylosis is found to be unavoidable, all motion of the joint should be prohibited, and the limb placed in the position in which it is most desirable it should be in that event.

I have said nothing here of counterirritation by tartar emetic pustulation, vesication with croton oil, and the use of issues, the seton, and the moxa; because, although sometimes serviceable, these means seldom afford the relief that has been so generally ascribed to them. I have certainly not, in my own practice, found them of much advantage, while occasionally I have thought they had acted decidedly prejudicially. Pustulation with tartar emetic is not only extremely painful, but it not unfrequently, in delicate persons, creates nausea and other disagreeable effects, rendering its continuance improper. The use of croton oil is hardly less objectionable. An issue may sometimes be established beneficially directly over the affected joint with the actual cautery, or the hot iron may be drawn linearly over its surface at several points, in a vertical direction. The seton should never be used in any articular disease as a counterirritant.

In rheumatic and gouty affections of the joints the most reliable remedy is the wine of the seed of colchicum. Its efficacy will generally be greatly increased, especially in young, vigorous subjects, if its exhibition be preceded by an active purgative, and the loss of ten, fifteen, or twenty ounces of blood. The best plan is to give one drachm of the wine every evening at bedtime in union with one-third to half a grain of morphia, such a course being far preferable to smaller doses frequently repeated. Thus administered, it rapidly subdues morbid action, relieving pain, depurating the blood, and expelling or neutralizing the arthritic poison. When there is much arterial excitement, as evinced by a full, bounding, and frequent state of the pulse, the saturated tincture of aconite will come in play, from three to four drops being given every three, five, or six hours, either alone, or, what is usually better, in union with a minute quantity of antimony and the sixth of a grain of morphia, in order to produce a more powerful diaphoretic impression. In the use of these several articles, great caution is needful that the dose be not carried too far, or the remedy continued too long.

If, after proper depletion has been practised, the disease be found to be unusually rebellious, calomel and opium may be cautiously employed, with a view to gentle ptyalism. In this condition of the system, quinine will often be highly serviceable, especially if it be administered in large doses in combination with morphia or Dover's powder. The alkalies, especially the carbonate of sodium, taken in strong lemonade, are beneficial in neutralizing the acid state of the blood and in improving the tone of the stomach.

As a local application, nothing will be more beneficial than soap liniment with laudanum and aconite, well rubbed on twice a day, and retained constantly upon the affected joint with flannel, covered with oiled silk. This may be succeeded, if the disease be inclined to linger, by vesication with cantharidal collodion.

In syphilitic synovitis, the great remedy, as stated elsewhere, is iodide of potassium, conjoined, in obstinate cases, with mercury, carried to gentle ptyalism. Other means, both general and local, such as have already been adverted to, are not to be neglected.

SECT. V.—DROPSY OF THE JOINTS.

Dropsy is an accumulation of fluid in the interior of an articulation, generally a result of chronic disease of the synovial membrane. It is most common in the ginglymoid joints, as the knee, elbow, and ankle, especially the first, which suffers more frequently in this way than any other.

The causes are both local and constitutional. Among the former may be classed different kinds of accidents, as sprains, blows, concussion, dislocation, and the presence of interarticular concretions, irritating the synovial membrane, and inducing an inordinate secretory action in its vessels. Severe and long-continued exercise, attended with excessive fatigue of the joints, may also excite the disease.

The constitutional causes are not always very obvious. Very often the disease is associated with, or directly dependent upon, a rheumatic state of the system, as is clearly evinced by the consentaneous existence of rheumatic suffering in other parts of the body. Gout occasionally produces a similar effect. In tertiary syphilis, it is not uncommon to meet with dropsy in several of the joints simultaneously, especially in the knee and elbow, and I believe that such an effect will be more certainly brought about if the individual has been subjected to severe courses of mercury for the cure of the primary

affection. When a strong predisposition to the disease exists, the slightest causes are generally sufficient to call it into action. In weak, strumous subjects, it is occasionally a sequel of typhoid fever, scarlatina, measles, and smallpox. Suppression of the cutaneous perspiration may also induce it; and in many cases it comes on without any assignable reason.

The *symptoms* are generally well marked, the most prominent and reliable, in a diagnostic point of view, being a loss of the natural contour of the joint, and the existence of a soft, elastic, and irregularly circumscribed swelling. The skin ordinarily retains its normal color, and the motion of the articulation, although considerably impeded, is rarely attended with much pain or inconvenience. The tumor affords distinct fluctuation, and is most conspicuous where the ligaments of the joint are loose and superficial. In the wrist, for example, it is most apparent at the anterior and posterior aspects of the joint; in the ankle, in front of the malleolar processes, a short distance above the instep; in the shoulder, in the space between the deltoid and pectoral muscles; in the knee, at the sides of the patella. In the latter, where the swelling is often double, its shape and consistence are materially influenced by the movements of the limb, being softer and more decidedly fluctuating in extension than in flexion. Pressure upon the tumor is seldom productive of much pain; generally, indeed, it causes merely a little uneasiness, or a sense of tenderness. In cases of long standing there is sometimes considerable enlargement of the subcutaneous veins, but this is uncommon.

The progress of these dropsical affections is generally very chronic, many months often elapsing before the tumor attains any considerable bulk. Sometimes, however, the reverse is true; in the knee, in particular, frequently large collections occur within a few weeks. Their march is usually most rapid in rheumatic and gouty subjects, and after attacks of the exanthematous fevers.

In regard to the diagnosis, the history of the disease, the change in the contour of the joint, the fluctuating and indolent character of the swelling, and the comparative freedom of motion of the affected structures, will generally serve to prevent error. If, after the swelling has been thoroughly scrutinized, any doubt exist it may at once be dispelled by the insertion of a very delicate needle, the nature of the escaping fluid being characteristic.

The most important *pathological* changes in this affection, especially in cases of long standing, are opacity and thickening of the synovial membrane, with some degree of vascularity, the vessels being spread over the diseased surface in delicate, arborescent lines, widely separated from each other. Occasionally slight deposits or patches of lymph exist, giving the part a rough, uneven appearance. The cartilages and bones present no perceptible changes, nor do the muscles and other parts around the joint, except that they are more less displaced by the dropsical distension. When the accumulation is very great, the capsular ligaments, pressed upon in every direction, become very much stretched and attenuated. Indeed, in the worst forms of the disease they may be so much distended as to give way, thus allowing the fluid to diffuse itself among the surrounding structures.

The dropsical fluid is generally of a pale, yellowish, straw or amber color, and of a ropy, unctuous, or sero-oleaginous consistence; sometimes it is turbid, whey-like, or sanguinolent, and intermixed with flakes, shreds, or masses of lymph. Its quantity is variable, depending upon the size of the joint, the duration of the case, and other circumstances. In the knee it frequently ranges from sixteen to twenty ounces.

The prognosis is always more favorable, other things being equal, when the swelling is recent and small than when it is of long standing, large, and attended with serious lesion of the synovial membrane. In the latter case the disease is often extremely obstinate, and may become dangerous, as it is liable to be followed by disorganization of the articular cartilages and bones. Ankylosis is not uncommon.

Treatment.—In the treatment of dropsy of a joint it must be borne in mind that it is not a disease, but, like dropsy everywhere else, merely a symptom of disease. Hence, the very first and most important object is to remove the cause upon which the presence of the fluid depends. The question will, therefore, necessarily arise, in every instance, what has been the origin of the affection? Has it been local or constitutional? Upon the success with which this question is answered will mainly depend the success of our remedies.

When the affection is of a purely local nature, as when it is caused by a sprain, contusion, or other injury, topical remedies alone will generally suffice to effect a cure, especially if assisted by an occasional purge and a properly regulated diet. The means to be chiefly relied upon are, perfect quietude of the affected joint, stimulating embrocations, and vesicants. In the milder forms of dropsy, frictions with iodinized lotions, soap lini-

ment, camphorated spirit, and mercurial unguents seldom fail to make a rapid and decided impression upon the absorbent vessels of the joint, as is shown by the speedy diminution of the size and tension of the swelling. They should be rubbed upon the whole of the affected surface twice a day with the bare hand until a decided glow is produced, the parts being well supported in the interval with the bandage, either alone or aided by wet sponge compresses, the compression thus produced powerfully promoting the reduction of the effused fluid. When the absorbents have been fairly roused as denoted by the gradually decreasing volume of the sac, the inunctions may often be advantageously preceded by the cold douche, or by the hot and cold, applied in immediate succession.

When there is evidence of incited action, as when the surface is hot and tender, re-frigerating lotions, consisting simply of cold water, or of water impregnated with acetate of lead and opium, must be employed; for so long as the capillary vessels are in a state of irritation, little benefit can be expected from sorbefacients, properly so called. Even leeching and brisk purgation may then be necessary.

In obstinate cases there is no topical remedy at all comparable to a blister, well sprinkled with morphia, and retained until the epidermis is thoroughly raised. The discharge is promoted by warm water dressings, and the blister is reapplied as soon as the surface is partially cicatrized. This method is much more salutary than that of keeping open the sore with irritating salves, as it exerts a more direct effect upon the absorbent vessels, at the same time that it is much less painful.

Pustulation with tartar emetic ointment and croton oil, so much vaunted by some prac-titioners, is generally hurtful; and as to issues and setons, their employment is never indicated, as the object may always be attained by milder means.

When the affection is of a rheumatic, gouty, syphilitic, or strumous origin, colchicum, mercury, iodide of potassium, and kindred articles, are the means chiefly to be relied upon. Dropsy that is symptomatic of fever, or of some of the eruptive diseases, often disappears spontaneously, as the patient improves in health and vigor, or readily yields to mild measures, particularly tonics, and change of air. Ordinary hydragogue medicines afford little, if any, relief in this affection in any of its forms.

As the joint will necessarily remain weak for a long time after the removal of the fluid, it should be well supported with a gum elastic cap, fig. 597, or a suitable bandage, and kept cool by frequent ablutions with alcohol and water. Fatigue must, of course, be avoided.

Fig. 597.

Finally, when the disease is unusually obstinate, relief should be sought by evacuating the fluid with the aspirator, or by subcutaneous puncture with a delicate trocar or bistoury, inserted in such a manner as to make a valve-like opening, at the most superficial and dependent portion of the swelling, at least two inches from its boundaries, its point being carried along the connective tissue until it reaches the sac. Thus performed, no pos-sible injury can result from the operation, while, by removing the fluid, over which the absorbents have no longer any control, it affords the only chance of relief. The opening is immediately closed with collodion, supported by a compress and bandage; and for some days the limb is kept perfectly quiet, light diet being enjoined, and every precaution taken to prevent inflammation. Reaccumulation is guarded against by the means already indicated.

I have not been so bold as to use injections for the permanent cure of this affection, convinced that the practice must be fraught with danger. The article recommended for this purpose, by Bonnet, Velpeau, and others, is tincture of iodine, diluted with two, three, or four parts of water, introduced subcutaneously with a syringe, to the amount of several ounces, and retained for a few minutes, the joint being pressed slightly during its sojourn, in order to bring the solution fully in contact with the diseased sac. It is then permitted to flow off spontaneously, when the opening is carefully closed, and the case treated upon general antiphlogistic principles. Of the safety, and, consequently, the pro-priety of this operation, great doubt is entertained by many practitioners, and, I think, justly so; for, although it has succeeded in some cases, it is certain that in others it has been followed by such a degree of inflammation as to imperil both limb and life.

SECT. VI.—MOVABLE AND ADHERENT BODIES WITHIN THE JOINTS.

Various kinds of bodies, mostly movable, but sometimes adherent, are liable to form in the cavity of the joints, where, interfering with the functions of the opposing surfaces, they become a source of much annoyance, and sometimes even of intense suffering.

Ambrose Paré, in 1558, was the first to call attention to such bodies, which are divisible into several classes, differing materially in their structure.

1. *Interarticular cartilages*, as they are called, or osseous concretions, are liable to form in various joints, particularly in the ginglymoid, as the knee, elbow, wrist, and jaw, the first, however, being apparently their favorite seat, for it is there that they occur most frequently, and attain their greatest bulk. The orbicular joints rarely suffer ; a circumstance which probably depends mainly upon the conformation of the articular surfaces opposing their development in the one case, and favoring it in the other.

The size, number, form, color, consistence, and structure of these bodies are liable to much diversity. In the knee, they sometimes acquire the dimensions of the patella, or of a hen's egg. Their number is generally in an inverse ratio to their volume. When very large there is often only one, whereas under opposite circumstances there may be several dozens. In one case, as many as sixty were found. The largest number I have ever known to be removed from one joint was thirty-eight, varying from the volume of a pea to that of a pullet's egg. They are, for the most part, of a whitish, grayish, or pale straw color ; while their consistence, like their structure, ranges from that of fibro-cartilage to that of bone, with every possible intermediate gradation. Their shape is generally very materially modified by that of the joint in which they are developed. Thus, in the knee they are often, if, indeed, not commonly, of an irregularly flattened figure, not unlike that of the patella, or they resemble a disk, convex on one side, and concave on the other, in conformity with the outline of the condyles of the femur and the head of the tibia. In many cases, again, even in the knee, they are of a lenticular, rounded, or ovoidal shape. Consisting usually of a single mass, they are sometimes marked off into several lobules, connected together by condensed connective substance. Their surface may be perfectly smooth, or partly smooth and partly rough.

The structure of these bodies varies. In their earlier stages it is generally fibrous, but as they advance in age they assume the character of cartilage, and ultimately that of osseous matter. The process of conversion from cartilage to bone is generally very gradual, and almost always begins in the centre of the concretion, although occasionally it occurs simultaneously both at the centre and at the periphery, or first at the surface and afterwards in the interior. When several such bodies coexist, they often exhibit material differences in their development ; some being comparatively soft, evidently from their cartilaginous nature, and others very hard and osseous.

The immediate cause for these formations is chronic inflammation, leading to the development of neoplasms upon the fringes of the synovial membrane, or to the abnormal proliferation of the articular cartilage, thus giving rise to what is denominated ecchondrosis. The harder varieties, the real osteophytes, as they may be called, have their origin either in the periosteum immediately beneath the synovial membrane, or near the border of the articular cartilage, from which they are gradually detached, and thrust into the affected joint. Finally, there are cases in which, as was shown by the late Mr. Teale, of Leeds, these formations are simply fragments of articular cartilage or bone, separated either by accident or by a slow process of exfoliation consequent upon external violence. The fact that the more ordinary forms of these bodies are susceptible of various transformations shows that they have an appropriate circulation, and also that this circulation continues in force long after they lose their attachment. The period at which they become loose, or floating, depends, no doubt, very much upon the amount of friction to which they are subjected, and the amount of atrophy which they experience after their development has reached the osseous or cartilagino-osseous point. Their original connection is usually effected through the medium of a short, narrow pedicle.

The size and shape of these bodies are well represented in fig. 598, from a drawing of several in a collection of thirty-eight, for which I am indebted to Dr. John T. Berry, of Kentucky, who removed them, without any untoward occurrence, from the knee of a negro, upwards of thirty-five years of age. When quite young, he received a slight injury upon the joint, which, although not painful, was soon followed by considerable enlargement. Two years prior to the operation, he perceived a small round movable tumor immediately above the external condyle, which was followed in about twelve months by two others just above the inner part of the knee. These swellings gave him but little trouble, with the exception of some stiffness in the articulation. Occasionally, however, the external one changed its position, slipping round to the anterior surface of the thigh, above the patella, where it interfered so much with walking that the man was immediately obliged to sit down, and push it back into its original position. An incision being made into the external tumor, the concretions were readily extracted, having all been contained in one sac, of a

dense, firm consistence, which occupied the lower part of the front of the thigh, and communicated with the cavity of the joint. There were thirty-eight altogether, from the

Fig. 598.
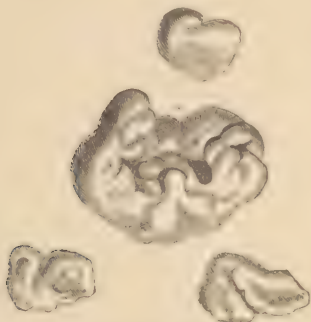
Loose Articular Concretions.

Fig. 599.

Adherent Articular Concretions.

volume of a pea to that of a pullet's egg, of a whitish, glistening appearance, rough or pitted on the surface, and of various configurations, as spherical, oval, lobulated, or angular. Fig. 599 exhibits several bodies of this kind as they lie in the joint attached to the synovial membrane, from a specimen in my collection.

The *symptoms* declarative of the presence of interarticular bodies are often characteristic, particularly when these substances occur in the knee. There are, however, on the other hand, cases where the nature of the disorder is so obscure as to elude, at least for a time, the most careful examination. The intruder, if large, generally causes but little pain, whereas, if it be small, and floating, it is very liable to be wedged in between the articular surfaces, so as to occasion severe suffering, followed, if the accident be frequently repeated, by violent synovitis. When, for example, the interarticular substance slips behind the patella, as the patient is standing or walking, he is often suddenly seized with violent pain, which instantly compels him to sit down, in order to save himself from falling. In the night, his sleep is liable to be disturbed by any inadvertent movement of the limb that may favor displacement of the concretion; and when the disease has existed for a long time, and is attended with much relaxation of the ligaments, any accident of the kind, however trivial, is almost sure to produce excruciating agony, often attended with syncope.

When the extraneous substance slips about habitually, it is sure not only to create pain, keeping the joint constantly tender and uncomfortable, but also in a state of enlargement, both by interstitial deposits in the surrounding structures and by increase of synovial fluid. The intumescence, however, is rarely so great as to prevent the surgeon from feeling the concretion, or pushing it about from one point to another. In the knee, it generally forms a marked projection on the side of the patella, more frequently on the external than the internal, its outline being distinguishable both by sight and touch. Cases occur in which, retreating to a particular part of the joint, it remains comparatively harmless, until it leaves its lurking-place and goes to some other, thus causing a renewal of all the former trouble. As the affection progresses, the joint becomes more and more tender, swollen, and feeble; the synovial membrane, constantly fretted by the friction of the concretion, pours out an additional quantity of its appropriate secretion; the ligaments become greatly relaxed, and the patient, at first merely limping, is at length rendered permanently lame and helpless.

The most important diagnostic signs are, the suddenness with which the joint is deprived of its use, the severity of the concomitant pain, the ability of the surgeon to feel, see, and push about the concretion, and the facility with which the patient can generally relieve himself by his own efforts. The chronic nature of the disease, the absence of external injury, and the frequent recurrence of the symptoms from the most trivial circumstances, afford important collateral evidence of the character of the affection.

Although the complaint under consideration is not generally dangerous, yet, as it often materially interferes with the movements of the joints in which it occurs, and does not

admit of permanent relief, except by surgical operation, which is itself always hazardous, we cannot be too cautious in forming our prognosis. The removal of the concretion, unless very small and soft, by absorption, is impossible.

Treatment.—The treatment is palliative and radical. So long as the concretion remains quiet and does not occasion any material inconvenience, or serious embarrassment in the functions of the joint, the most judicious plan is to let it alone, care being taken to support the parts with a gum elastic cap, or some other suitable contrivance, to prevent the substance from slipping about, and thus doing harm. The relief afforded, however, is generally very transient, and, therefore, other and more efficient measures must be adopted.

Two procedures are in vogue for the removal of loose cartilages of the joints, the one being known as the operation by the direct incision, and the other, devised almost simultaneously by Goyrand and Syme, as the subcutaneous method. Concerning the comparative safety of these two expedients various opinions have been expressed; but it is now well ascertained that the preponderance is decidely in favor of the new operation, or the indirect method, while the other furnishes a greater number of cures. Thus, of 216 cases collected by Dr. Hugo M. Benndorf, of Leipzig, in 1868, in which the direct incision was practised, 143 recovered without any accidents, 41 ended fatally, and 32 were followed by bad symptoms. Of 50 cases treated subcutaneously, 28 were cured, 5 perished, 5 had bad symptoms, and in 12 the operation was not completed. It will thus be perceived that the direct method furnishes 81 per cent. of cures, against 66 of the subcutaneous, with 19 per cent. of fatal issues for the former, and 10 per cent. for the latter. The statistics, brought together by Hippolyte Larrey, in 1861, attest the same fact. Of 167 cases, 129 were by the direct incision, and of these 96 were cured, 5 failed, and 28 died. Of 38 cases treated subcutaneously, 19 recovered, 14 failed, and 5 terminated fatally. Mr. Square, of Plymouth, England, had, up to 1871, operated successfully in 24 cases by the indirect method. Dr. G. Gaujot, in 1881, published an analysis of 54 cases treated since 1863 by the direct method, of which only 3 ended fatally; and from all I can gather upon the subject, it may fairly be assumed that, despite its greater danger, the preponderance of authority of the present day is decidely in favor of the direct incision, as affording a better opportunity of removing effused blood than in the subcutaneous operation in which more or less is so liable to find its way into the affected joint, and where its presence is always productive of mischief. In the cases collected by Gaujot, antisepticism did not seem to offer any special immunity from danger. In the time of Benjamin Bell, of Edinburgh, early in the present century, extraction of these concretions was regarded as such a dangerous procedure that that eminent surgeon strongly recommended amputation as far preferable.

One of the great objections to the subcutaneous operation is the difficulty of fixing the floating cartilage in a position favorable to its easy and successful extraction. In this respect, the direct method possesses a decided advantage. Apart from this consideration, experience has shown that the subcutaneous operation, however well performed, is occasionally followed by high inflammation, imperilling both limb and life. It, nevertheless, I conceive, generally merits the preference. Before either operation of so hazardous a character is undertaken the patient should be subjected to a most rigid course of treatment, consisting of perfect rest of the affected joint, with light diet, and an occasional laxative, extending over the better part of a fortnight.

The subcutaneous section of the knee will serve as a type of the operation upon the other joints. The limb being extended upon a table, the foreign body is brought to the upper and outer side of the patella, beneath the large external muscle, where it is to be securely held by an assistant, either with the fingers or with an acupuncture needle, while the surgeon introduces a long, narrow bistoury, from above downwards, into the synovial pouch, which is then freely divided, so as to permit the concretion to be pushed through the opening into the subcutaneous connective tissue, or among the structures exterior to the joint, entirely beyond the serous lining. The puncture is covered with collodion, and a compress is gently bound upon the knee, between it and the concretion, the object being the promotion of speedy union of the edges of the articular wound. The limb is kept perfectly at rest, free use being made of cold water-dressing and other antiphlogistics. When the inner wound is healed, the extraneous substance may be removed by simple incision; or, if not a source of inconvenience, it may be allowed to remain in its new position, where it will soon become imbedded in plastic material, and so prove comparatively harmless. In some cases, indeed, it is speedily absorbed.

In the direct operation, the method now generally adopted, performed under antiseptic precautions, the wound should immediately be closed with the greatest possible care, with

a view to the effectual exclusion of the air, the great danger after such a procedure. If the concretion be still attached, severance should be effected with the knife or scissors, any pulling with the forceps being inadmissible. The remarkable tolerance, even of the largest joints, after free incision practised for such a purpose, is well shown in the case of Dr. Berry, above referred to, in which thirty-eight concretions, some of them of large size, were extracted from the knee at one operation, without a solitary bad symptom.

The after-treatment, in both methods, must be conducted upon the same general principles. During the first eight or ten days the system should be steadily kept under the full influence of opium, the diet should be very light and simple, and the affected joint should be placed in the most easy and comfortable position, free use being made of leeches, vesicants, and lotions of lead and laudanum in the event of inordinate action. If matter form, speedy vent should be afforded. Amputation or resection may be necessary when, after an attempt has been made to save the joint, life is assailed by hectic irritation, pyemia, or gangrene of the limb.

It has been proposed, in cases of loose articular concretions, by different surgeons, more especially by Dieffenbach, Wolf, Jobert, Dumoulin, and Leroy d'Etiolles, to fix the offending substance in a harmless portion of the joint by means of steel pins, serrefines, or subcutaneous wire ligatures, until it has formed firm adhesions in its new situation. The procedure, however, has not met with any favor, as it is not only difficult of execution, but sometimes even dangerous, several instances having been recorded in which it was followed by violent inflammation and even copious suppuration.

2. The movable joints are occasionally the seat of *gouty concretions*, which, from their color and consistence, have received the name of chalk-stones. They are composed of urate of sodium, a peculiar fatty matter, phosphate and carbonate of lime, and a minute quantity of carbonate of magnesium. In one case, that of an old man, I found these concretions in nearly all the principal joints of the body, in small amorphous masses of a whitish color, and of a soft, unctuous consistence. Sometimes the concretions are perfectly smooth and round; more commonly, however, they are rough and irregular, grooved or nodulated. They are generally small, but may acquire the volume of an egg. Their origin is always connected with a gouty diathesis.

The *treatment* of this form of concretion is chiefly constitutional, directed to the removal of the gouty diathesis, with which its origin is so intimately associated. Colchicum and aconite, with an occasional mercurial purge, the free use of lemon-juice, and a diet composed mainly of bread, fish, eggs, milk, and the lighter vegetables, constitute the chief remedies. For a long time, means should be employed to depurate the blood, and to keep up a healthy state of the digestive organs, with an active condition of the renal secretion. If the joint ulcerate, or threaten to do so, extrusion should be effected; in the former case by direct incision, in the latter by the subcutaneous method.

3. The synovial membrane is occasionally the seat of *fibrous tumors*. They occur in different joints, but principally in that of the knee, where several sometimes coexist, varying from the volume of a bean to that of a large almond. On one occasion, I removed a growth of this description fully as large as a pullet's egg. It was of an elongated, flattened, pyriform shape, and was attached, by a short, narrow pedicle, to the upper and anterior part of the inner condyle. The patient, a man of twenty-seven, had labored under synovial irritation for many years, attended with partial ankylosis, and much pain and tenderness, which were always aggravated upon the slightest exertion. A subcutaneous incision being made into the articulation, the tumor was detached by a few turns of the point of the knife, and immediately extracted with a very delicate, slender pair of forceps. The wound, closed with collodion, healed by the first intention, no untoward symptom occurring, as far as the joint was concerned. Some erysipelas, however, appeared upon the skin, and a week afterwards a large abscess formed at the inner and middle part of the thigh, which somewhat retarded recovery. Another tumor, doubtless of a similar nature, was found occupying the deeper portion of the joint, but, dreading further interference, it was thought best not to meddle with it. The functions of the knee were much improved by the operation. The tumor was of a pale greenish color, extremely firm and tough in consistence, smooth, glistening, and somewhat vascular on the surface, and of a distinctly fibrous structure.

4. What is known as the *fimbriated degeneration* of the synovial membrane is sometimes met with, chiefly in the larger joints, as in those of the knee and hip, and consists of innumerable little bodies of all sizes, from a millet seed up to that of a pea, of a pale yellowish or whitish color, and bearing a very close resemblance to the epiploic appendages of the large intestine. Of a smooth, glistening appearance, they stud the free surface

of the synovial membrane in every direction, being connected to it either by a broad base, or, as is more generally the case, by a narrow, slender pedicle. Their structure is evidently of a fibrous character, interspersed with fatty cells, the whole originating in a deposit of plastic matter, which assumes the peculiar arrangement in question in consequence of the friction exerted upon it by the opposing surfaces of the joint in which the substance is effused. The accompanying cut, fig. 600, from Pirrie, affords an excellent illustration of this form of morbid growth.

Fig. 600.   Fig. 601.

Fimbriated Growths of the Synovial Membrane.
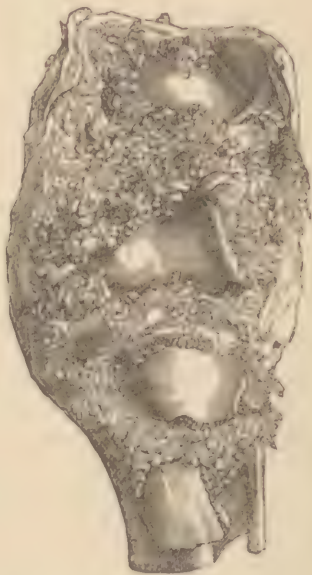
The Synovial Membrane of the Knee-joint
Studded with Numerous Melon Seed-shaped
Bodies, the Patella being turned down.

The symptoms occasioned by the fimbriated synovial membrane are altogether of a mechanical character, consisting of pain and stiffness, and of a grating sensation during exercise, along with more or less swelling in and around the joint, from inflammatory deposits. There are no diagnostic symptoms, and the treatment must, therefore, be conducted upon general principles.

5. *Fibroid bodies*, of the size and shape of cucumber, squash, or melon seeds occasionally form in the joints, doubtless in the same manner and from the same causes as the larger concretions. The annexed cut, fig. 601, from Druitt, presents a beautiful illustration of a remarkable case of these peculiar growths.

SECT. VII.—TUBERCULOSIS OF THE JOINTS.

1. GENERAL OBSERVATIONS.

Tuberculosis of the joints, formerly known as white swelling, is an extremely common affection. Beginning either in the areolar substance of the articular extremities of the bones, or in the synovial membrane, or, as, perhaps, not unfrequently happens, simultaneously, or nearly simultaneously, in both of these structures, it is almost peculiar to children under ten years of age, and generally pursues a chronic course, although occasionally it proceeds with so much rapidity as to entitle it to the distinction of an acute malady. However this may be, it seldom stops until it has produced the most extensive textural ravages, consisting in the destruction, either partial or complete, of the affected articulation. Constitutional involvement is usually well marked, especially in the latter stages of the complaint, when it is also not uncommon to find serious lesion of some of the internal viscera, as the lungs, spleen, and mesenteric glands. The disease, as the name

imports, is essentially of a strumous nature, and can, therefore, occur only in persons of a strumous diathesis.

The joints that are most prone to suffer from tuberculosis are the movable, particularly the hip, knee, ankle, elbow, and wrist. Those of the tarsus are also remarkably liable to it. Sometimes several joints are involved simultaneously; and instances occur in which the disease is, apparently, hereditary.

Etiology.—The exciting causes of this affection are generally very obscure, if not utterly inscrutable. The surgeon, it is true, is often told that the patient, perhaps weeks or months before the appearance of the characteristic phenomena, received some injury, as a blow, fall, or kick, or that the affected joint had been sprained, bruised, or twisted; but such information is usually little reliable, or if such an occurrence really did take place, it, probably, exerted little, if any, influence in developing the complaint. Unless very severe, it could no more provoke tuberculosis of a joint than a similar injury of the chest tuberculosis of the lungs, or of the head tuberculosis of the arachnoid membrane.

Exposure to cold, intense or protracted, is particularly liable to prove prejudicial in persons of feeble constitution, with an impoverished state of the blood. The influence of this agency in exciting pulmonary phthisis has long been recognized. Living in damp, underground, ill-lighted, and ill-ventilated apartments operates in a similar manner. Simple suppression of the cutaneous perspiration, suddenly induced, as when an individual is exposed to a strong current of air, is also liable to produce the disease, especially in one predisposed to its occurrence. The use of unwholesome food, chronic disorder of the digestive apparatus, imperfect assimilation, or inadequate nutrition, protracted courses of mercury, and the exhaustion consequent upon copious and repeated hemorrhages, infantile cholera, chronic diarrhœa, scarlatina, measles, smallpox, typhoid fever, and in short whatever has a tendency to enfeeble the system and derange the blood, are so many predisposing causes of the disease, if they do not actually call it into activity.

It has frequently been asserted that rheumatism might induce this disease, but this is questionable. The fact is it is not at all probable that it ever exerts such an influence; for, in the first place, it is well known that tuberculosis is exceedingly uncommon in rheumatic subjects, and, in the second, that, when disease of the joints shows itself in such persons, it is very different from strumous disease.

Persons of fair complexion, light hair and eyes, a delicate skin, and a languid circulation, with a tendency to eruptions of the scalp and enlargement of the lymphatic glands, are most liable to tuberculosis of the joints. In many cases the strumous diathesis exists in a marked degree, the tumid lip and belly, the long eyelashes, the cold extremities, the flattened shape of the fingers, and the disordered condition of the digestive organs, affording unmistakable evidence of its presence.

No one who is in the habit of meeting with this disease can fail to notice the different temperaments of those who are most subject to its attacks. These are, according to my observations, the sanguine and the lymphatic, or a combination of both. In the former, the characteristics are, a rosy hue of the countenance, a well-developed muscular system, with a tendency, frequently, to a certain degree of embonpoint, a vigorous circulation of the skin, warm extremities, and an active state of the intellect. In the latter everything is completely reversed. The face is pale, often swollen and pasty, the muscles are soft and flabby, the feet are habitually cold, the cutaneous circulation is feeble, the pupils are dilated, and the mind is sluggish. In both, but more particularly in the lymphatic, the belly and upper lip are often remarkably tumid, and most expressive of the tubercular diathesis. These two varieties of temperament, with their modifications, deserve careful consideration, as they form the basis of important therapeutic indications in the disease in question.

Morbid Anatomy and Pathology.—The morbid changes induced by this disease vary according to the different stages of its progress, the earlier closely resembling those of ordinary inflammation. The synovial membrane, which is commonly first implicated in the morbid action, affords evidence of slight vascularity, a few delicate, straggling vessels, loaded with blood, being observable upon its surface, with some degree of opacity and softening. An appearance of thickening is often imparted to it, from a deposit of lymph, which, being poured out, perhaps quite freely, soon assumes a pulpy consistence and a pale yellowish or greenish color. Sometimes it is shreddy, tomentose, or filamentous. The articular cartilage, if seriously involved in the inflammation, is of a dull whitish or slightly grayish aspect and somewhat thickened, softened, and partially separated from its osseous connections. The cancellated structure of the bones is abnormally vascular, light, porous, humid, and at the same time easily cut and broken. Not unfrequently its cells are dis-

tended with yellowish tubercular matter, of a semisolid, caseous consistence ; or, this substance presents itself in distinct granules free or encysted, and, perhaps, not larger than a millet seed. The ligaments usually suffer early, being abnormally red, tumefied, and softened. The synovial fluid is generally increased in quantity, but rarely to any considerable extent.

As the disease advances, the alterations become more distinctly defined, for, as the disorganizing process is now in full play, its devastating effects are plainly visible in every portion of the joint. The lymph increases in quantity, and is often intermixed with sero-purulent matter, or thick, greenish-looking pus. The tufts of the synovial membrane are converted into soft, gelatinous, fungous, tubercular granulations, which gradually extend over the cartilage, imparting to it an ulcerated, or worm-eaten appearance, and eventually destroying it. The bony structure is at length also invaded by the granulations, rendering it very red, soft, carious, rough, and fragile. The ligaments exhibit well-marked signs of inflammation, being loose and spongy at one point, attenuated at another, and, perhaps, thickened or hypertrophied at a third. The microscopical appearances of ulcerated cartilage and carious bone, the result of changes wrought during the progress of strumous disease of the joints, are well shown in figs. 602 and 603, from Barwell.

Fig. 602.
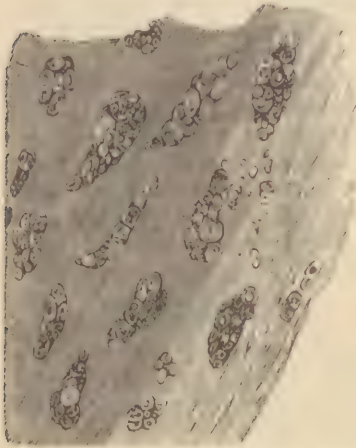
Fig. 603.

Section of a Strumous Ulcer of a Cartilage, magnified 500 diameters.
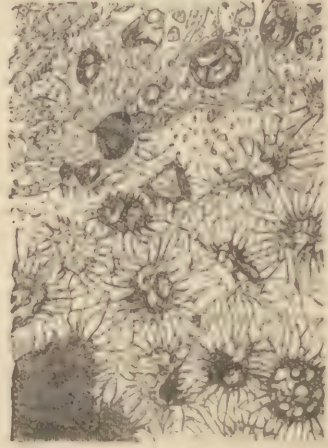
Section of Strumous Tibia, the upper portion exhibiting a mere pultaceous Mass, interspersed with dark Cells. Nucleated cells are often found in the Lacunæ, a very large one, the 1.85 of a line in diameter, is seen in the lower right corner of the cut.

The disease having reached its acme, the structures of the joint are completely subverted, with hardly any trace of their original appearances. Pus is now usually seen, often, indeed, in large quantity, with all the qualities of strumous matter. This, however, is not always the case ; for, at times, it is thick and pultaceous, caseous, ichorous, or sero-sanguinolent. In some instances it is very thin, and almost black, evidently from the effects of the necrosed condition of the bones.

If death take place after a process of recovery has been set up, the joint will be found to be filled by a white, fibrous, organized substance, the extremities of the bones being ankylosed, or firmly attached by the new matter to the surrounding structures. It is very rare for a new socket to be formed, and yet this is not impossible. In time, the artificial joint may admit of considerable motion, but, in general, this is extremely restricted. Occasionally an imperfect ligament is developed around the bony remnants, the surface of which may even become slightly tipped with cartilage. Finally, osseous growths, short, irregular, and friable, sometimes make their appearance upon the bones in the vicinity of the former disease.

The bodies of those who die of strumous disease of the joints usually exhibit serious pathological changes in some of the internal organs, as the direct result of the strumous cachexia, generally so well marked in the latter stages of the complaint. The structures which, according to my observation, are most liable to suffer, are the lungs, the spleen, and the mesenteric and pelvic lymphatic glands, which are sometimes completely crowded

with tubercles, in various stages of transformation. Dropsical effusions are also sufficiently common, especially in the peritoneal cavity and in the lower extremities.

Tubercles and cheesy deposits of the lungs are very common; they often exist in great numbers, especially in the summits of these organs, and they always exhibit the same characters as in ordinary phthisis. Cavities sometimes form, but death usually occurs before they attain any considerable magnitude. The bronchial glands generally participate in the pulmonary disease, being enlarged, softened, and tuberculized. Occasionally extensive adhesions are found between the lung and costal pleura, with or without serous and other effusions. The heart is seldom affected.

The peritoneum is sometimes extensively tuberculized, and considerable quantities of water are often found in its cavity. In children, the lymphatic glands of the pelvis and mesentery are liable to suffer from strumous deposits, and similar changes are occasionally witnessed in the spleen and kidney. In some instances the latter organs undergo the amyloid degeneration. The liver is often cirrhosed and hypertrophied. Now and then the glands of Peyer suffer. Tubercular meningitis is occasionally present, especially in very young children. The pancreas, stomach, bladder, and prostate gland are usually sound. The blood is very thin, and deficient in fibrin and coloring matter. The lower extremities, and even the hands, face, and genital organs, are, at times, anasarcous, especially when the system has been worn out by tubercular disease of different parts of the body.

Tuberculosis of a joint is, as the name implies, essentially a tubercular disease, and consists of tubercular degeneration of the synovial membrane, the result usually of infection from similar deposits beneath the articular cartilage. Modern investigations have conclusively demonstrated that fungous synovitis is not only the expression of a constitutional vice, but that it is frequently the source of general miliary tuberculosis. Some idea of the frequency of tubercular synovitis may be found from the observations of Koenig, of Göttingen, who proved the existence of local tubercles in not less than 69 out of 71 examples of white swelling of the hip-joint. Its malignant or infectious nature is clearly shown by Billroth, who found that 181, or 25 per cent., of 713 cases of fungous synovitis died of pulmonary consumption. These facts have led many modern surgeons to resort to early and complete resection of tubercular joints, with the view of preventing general dissemination of the disease, or to employ parenchymatous injections of weak solutions of iodine or carbolic acid with the hope of destroying the vitality of the tubercle corpuscles. How far this object may be accomplished is an open question.

Symptomatology.—In regard to the symptoms of this disease, they may, for the sake of more definite description, be divided into three stages, all tending from bad to worse.

In the first stage, the patient's suffering is generally insignificant, and is usually referred to the effects of cold, rheumatism, or some slight external injury. The chief complaint consists in some trivial pain, either in or about the joint, not fixed or steady, but wandering and intermittent, and liable to occasional exacerbations. If swelling be present, it is also very insignificant. The joint is usually somewhat stiff, and the patient is easily fatigued by exercise. The general health is unimpaired, or only slightly implicated.

By degrees these symptoms assume a more threatening character; for the disease has now attained its second stage, as is indicated by the changes wrought in the affected structures. The pain is now more severe, as well as more localized and deep-seated, and commonly requires active means for its relief. The patient is annoyed with spasmodic twitches, especially at night, and the affected limb is sensibly wasted and flabby. The joint is the seat of more or less swelling, attended with marked deformity and fluctuation, the result of the presence of an undue quantity of synovial fluid, or of this fluid and of lymph. The parts feel abnormally hot, and there is commonly a peculiar glossy, shining appearance of the skin, which induced the older surgeons to call this disease " white swelling." There is also, in this stage, usually some degree of enlargement of the subcutaneous veins. The constitutional symptoms keep steady pace with the local affection. The appetite and sleep are disordered, the bowels are irregular, and there are occasional paroxysms of fever, with evidences of emaciation and general discomfort.

In the third stage of the disease, the symptoms, both local and general, are strongly denotive of the horrible ravages of the morbid action. The joint and surrounding structures are swollen and enlarged to their utmost, hot, tense, discolored, immovable, exquisitely tender and painful, distended with pus, or pus and synovial fluid, and freely fluctuating under pressure. More or less displacement of the articulating surfaces generally exists, adding thus still further to the deformity. The pent-up matter, gradually approaching the skin, is at length spontaneously evacuated, much to the relief of the parts and

system, but the resulting sinuses, always slow in healing, often continue for years, especially when there is much diseased or dead bone.

The constitutional symptoms in this stage are those of hectic irritation. The patient, at least for a time, has regular vesperal exacerbations, the face is flushed, the pulse is excited, the sleep is impaired, and the surface, during the night, is drenched with copious sweats. Rapid emaciation ensues, the strength declines, and there is not unfrequently colliquative diarrhœa. Thus life may be gradually worn out by exhaustion, or, the discharge diminishing, reaction may take place, followed, sometimes even in apparently desperate cases, by ultimate recovery.

Suppuration, however, does not always take place in this stage of the complaint, or, if it does, there is either very little matter, or, what there is, is so soon absorbed as not to produce any characteristic symptoms. This is the case occasionally even when the greatest ravages have been committed. Sometimes the pus is situated altogether externally, but this is unusual. In other cases, again, also infrequent, it is formed both externally and internally. However this may be, the structures over and around the affected joint always participate in the morbid action, becoming hard, condensed, and enlarged from interstitial deposits.

The matter in scrofulous disease of the joints closely resembles the fluid of a cold abscess, or the pus of a pulmonary cavern, and is often intermixed with small, whitish particles, not unlike grains of soft-boiled rice, flakes of lymph, small clots of blood, and even the débris of articular cartilage, ligamentous tissue, or osseous matter. When long confined, it is apt to be very fetid. Permitted to stand for a while in a vessel, it separates into two parts, one at the bottom, solid and granular; the other at the top, fluid, and of a pale whey-like or oleaginous aspect. When an abscess of this kind has once fully emptied itself, the subsequent discharge is often of a gleety character, ichorous, or thin and bloody.

The quantity of matter may be very small, or so abundant as gradually but surely to exhaust the system. At times the suppuration is almost entirely suspended, perhaps, indeed, for several months, when, either suddenly or gradually, it reappears, and becomes as profuse as before. Once established, it has no special limit as to its duration, but may last, with hardly any intermission, for years. Whenever the discharge is unusually protracted, it may be assumed that there is extensive caries, if not also necrosis of the bony structures of the joint, especially if it be attended with an occasional escape of gritty substance.

Prognosis.—Tuberculosis of the joints is essentially a chronic disease, which, after an indefinite period, terminates either in recovery or in death. The recovery may be complete, both as it regards the part and system, or, the local action disappearing, the joint may be left weak and ankylosed, and the general health regain its original vigor; or, as not unfrequently happens, particularly after the process of disorganization has commenced, both the articulation and the constitution may remain for a long time, if not permanently, in a degraded and crippled condition.

Much, as it respects the result, will depend, in every instance, upon the state of the constitution, the presence or absence of complications, and, above all, the duration of the disease. Age also exercises an important influence, children living longer, and also having a much better chance of recovery, than young adults and middle-aged subjects, in whom, especially the latter, the affection often proceeds with extraordinary rapidity, sometimes ending fatally in a few months. When the constitution is naturally feeble, or when it has been rendered so by the intensity of the local suffering, the probability of an unfavorable termination will be much increased. Imperfect alimentation and intercurrent diseases, as typhoid, intermittent, and eruptive fevers, diarrhœa, dysentery, and erysipelas, often retard recovery, or hasten the fatal crisis. These and other affections, by establishing a drain upon the system, already exhausted by the local disease, are the principal causes of the mortality in tuberculosis of the joints. When the disorder proves fatal without such intervention, it will generally be found that death is directly due to the depressing effects of tuberculosis of the lungs, lymphatic glands, spleen, or peritoneum, so liable to show itself under such circumstances.

Much of the mortality of this disease, as well as most of the bad effects, both temporary and permanent, which it entails upon the affected articulation, results from neglect of appropriate management prior to the commencement of the disorganizing process. Properly treated at its beginning, it is, generally, as remediable as any ordinary chronic inflammation, although not, perhaps, so promptly. The morbid action receding, the effused materials are gradually absorbed, and the parts restored to their normal functions.

Arrived at its second stage, hardly any course of medication, however judiciously applied, will completely avert permanent rigidity, although life may not be at all in jeopardy. The morbid impression has already advanced too far to admit of easy recession ; a certain amount of structural lesion is present, and the patient will be fortunate if he ever completely regains the use of his joint. In the third stage, when the osseous, cartilaginous, and other textures are disintegrated and broken down ; when, perhaps, the interior of the joint is converted into a large chronic abscess ; when the limb is stiffened or immovable, and, finally, when the constitution is worn out by pain and hectic irritation, there will not only inevitably be loss of function, but also great danger of loss of life. If, under such circumstances, the patient survive, his recovery will be effected at the expense of much suffering, too often eventuating in premature decay and dissolution.

Treatment.—In the treatment of this affection, it must be remembered that, as it is generally, if not invariably, merely a local manifestation of a constitutional vice, topical remedies alone will not avail ; to prove efficient and truly useful, they must be combined with, and aided by, means addressed to the general system, with a view to the improvement both of the solids and fluids. It would be idle, in the present state of the science, to insist upon a course so palpably proper in itself and so long sanctioned by experience. We might as well expect to be able to cure consumption, or to ameliorate the condition of a person thus affected, by the exclusive employment of counterirritation and other external measures, as to cure tuberculosis of the joints without the aid of constitutional remedies. Again, in treating this disease it should not be forgotten that it consists of different stages, which, although they run imperceptibly into each other, are, nevertheless, of vast importance in a practical point of view.

Whatever may have been the duration of the disease when the treatment is commenced, the first and most essential element in its management is repose, absolute, unconditional, and persistent, not merely of the joint, but also of the body. Upon this subject there must be no compromise. The slightest departure from this injunction would at any period of the complaint be of great detriment to the patient's limb, while, in its more advanced stages, when the bones and cartilages are seriously involved and matter exists in the joint, it might endanger his life. When the disease is seated in the interior extremity, recumbency must be observed, not for days or weeks, but months.

The local remedies must be regulated by the progress of the affection and the condition of the constitution. If the disease is in its first stage, if the pain is violent and frequent in its recurrence, and if the general health remains unimpaired, we can scarcely fail to derive special benefit from the application of leeches, or, in their absence, from the use of a large blister. The leeches should be scattered over the affected joint, and the flow of blood encouraged for some time with cloths wrung out of warm water. Their number must depend upon circumstances, but, in general, from three to six will be sufficient for a child from three to six years of age. Sometimes a blister may advantageously be applied within a few days after the leeching, and I much prefer this mode of counterirritation to the employment of liniments, embrocations, croton oil, tartar emetic ointment, and iodinized lotions, which is always attended with friction, and for that reason is often prejudicial to the inflamed structures. By these means, conjoined with a plain, simple diet, consisting mainly of farinaceous articles, and an occasional laxative of blue mass and jalap, almost any case may be radically cured in a few months. If fever be present, or if decided plethora exist, as denoted by the state of the pulse, face, and skin, antimonial and saline preparations may be given. To relieve pain and secure sleep, opiates must be used with warm anodyne poultices or fomentations, or, what I have found to be of greater benefit, a lotion composed of soap liniment, laudanum, and tincture of aconite, applied by means of a fold of flannel, kept constantly wet, and covered with oiled silk. Cold applications are generally inadmissible both in this and in the other stages of the disease. When the skin is unusually dry, or the system more than commonly irritable, the localized steam bath, carefully administered, with a Dover's powder at night, is sometimes highly beneficial.

As permanent ankylosis cannot always be avoided, the affected joint should be carefully placed in the best position for future usefulness ; but this is a subject which will receive proper attention in a future section.

Although the treatment now laid down will usually be found to be very serviceable in the earlier stages of the complaint, there is, nevertheless, not a little diversity in regard to the nature of the internal remedies required in different cases. As already stated, there are two distinct classes of patients, the plethoric and the anemic, the former demanding, perhaps, a certain amount of depletion, while the latter will be most benefited

by tonics. I have not met with any cases where I thought the use of the lancet was indicated, and yet I am not prepared to say whether, when the inflammation and pain are very great, in a strong, robust child, soon after the commencement of the malady, venesection, to a small extent, might not be highly beneficial, in preventing suppuration and in saving structure; in general, however, the morbid action may be sufficiently repressed by saline medicines, in union with a minute quantity of tincture of aconite and tartar emetic, assisted, perhaps, by the application of a few leeches to the seat of the disease. In the anemic, a very common class of cases, tonics and stimulants are often required at the very commencement of the disease, consisting either of quinine and iron, or, what is peculiarly valuable, of cod-liver oil, in such doses as shall not prove offensive to the stomach. The diet should, of course, be of a corresponding character, with milk punch, wine, ale, or porter, to rebuild the system, and thus enable the affected parts the more effectually to resist the encroachments of the morbid action.

Absolute rest cannot be employed too soon in the treatment of joint-disease, and must be secured at all hazard, by splints or by extension and counterextension, conducted upon the same principles as in fractures of the lower extremities. The best material for splints is gutta-percha, plaster of Paris, undressed sole-leather, or trunk-maker's board, soaked in hot water, carefully adapted to the parts, and secured with a common roller. When dry, these articles form an admirable case, which may afterwards be padded with cotton, or any other soft substance, to ward off pressure.

Any malposition of the limb, caused by the contraction of the muscles, that cannot be rectified in this way, must be remedied with the tenotome. The effect of such an operation upon the future welfare of the part and system is often most striking, the pain and spasm being relieved as if by magic, and the limb becoming perfectly docile and manageable, especially if extended by the weight and pulley.

In the *second stage* of the affection, the most reliable local remedy is a large issue, to secure a free and permanent discharge of matter. If the case has not been seen before it has reached this crisis, some of the means already mentioned, as leeching and blistering, may be tried; but, unless they be promptly beneficial, no time should be wasted in their employment. The disease is now thoroughly aroused, and must, therefore, be met in the most decisive manner, to prevent its disorganizing and destructive effects. The best place, by far, for the issue is the most prominent part of the swelling, which is usually either directly over the joint or in its immediate vicinity. The nearer, in fact, the discharge is established to the diseased structures, the more likely will it be to be useful. The best issue is one made with the actual cautery, heated white, and gently pressed upon the part until a suitable eschar is formed; one about the size of a twenty-five cent piece if the patient is very young, or twice that size if he is twelve or fifteen years old, being a good average. The slough, which should not extend beyond the subcutaneous connective tissue, generally drops off within the week; and, during this period, as well as afterwards, the parts should be kept constantly covered with an elm or linseed poultice, renewed several times in the twenty-four hours. The discharge, if flagging, may be promoted by savine ointment, by simple cerate containing a few drops of nitric acid to the ounce, or, what I prefer, the occasional application, for a few hours, of a small blister. In this manner an abundant pyogenic discharge may readily be maintained for an almost indefinite period. The cautery may, if necessary, be reapplied at any time during the progress of the treatment.

The hot iron deserves a decided preference, for making an issue in this disease, over all other modes of cauterization, as affording not only a more copious and persistent flow of pus, but, what is of no little importance, making a much stronger, as well as a more permanent, impression upon the part and system. Although it is not always possible to determine how long the suppuration should be kept up, it will be well to let it continue until there is reason to believe that the violence of the morbid action has completely subsided. I have never, in any instance, experienced any bad effects from its protracted continuance; indeed, quite the contrary has been the case. If the discharge becomes offensive, as it often does in warm weather, deodorizers must be used, with a more frequent change of dressing. Occasionally the poultice, especially the linseed, causes painful and itchy eruptions around the sore, necessitating its temporary suspension, or the substitution of some more suitable application.

Besides these advantages, the raw surface left by this kind of issue affords an excellent opportunity for the local application of morphia, for combating the excessive pain and spasmodic twitchings of the muscles, which are so common in this complaint, and which are much more promptly subdued in this way than when this medicine is administered by

the mouth. The quantity necessary to produce the desired effect will, of course, depend upon circumstances; but, in general, from a quarter to a third of a grain will be required for a child three or four years old. Sometimes a dose of Dover's powder will allay the pain and quiet the system more effectually than anything else. The diet should be more or less nourishing, and tonics freely used, if there is marked debility.

When the course of the disease is chronic from its very commencement, as indicated by the absence of heat, spasmodic, starting pains at night, and freedom from suffering on manipulation and pressing the inflamed surfaces together, I know of no measure better calculated to restore the swollen, pulpy, and deformed articulation to its normal condition, than moderate compression exerted by means of the gum ammoniac and mercurial plaster, adhesive strips, or the plaster or water-glass bandage. With such a dressing the patient is enabled to go about on crutches and enjoy the benefit of exercise in the open air.

Professor Hueter, of Griefswald, who has little faith in the ordinary treatment of scrofulous inflammation of the joints, recommends the injection of fifteen drops of a three to five per cent. solution of carbolic acid into the affected bone or articulation in the earlier stages of the disease, or before suppuration has set in. If the remedy fail, he advises total excision. I have myself had no experience in this practice; but have no hesitation in pronouncing it to be entirely too exclusive.

When the disease has reached its *third stage*, the great point in the treatment is to limit suppuration and to promote the absorption of effused fluids, the most important local remedies being dilute tincture of iodine, chloride of ammonium, and cantharidal collodion, along with perfect rest of the affected joint, and the liberal use of anodynes, to allay pain and secure sleep. All active and depressing measures, are, of course, out of the question, as they would only tend to do mischief. If the quantity of pus is small, this treatment may be sufficient to cause its removal, especially repeated vesication; if, on the other hand, the accumulation is considerable, the only thing to be done is to afford artificial evacuation, subcutaneously, if there be as yet no serious structural lesion, or by direct incision when the matter is superficial, and denotive, by its fluctuation and the great size of the swelling, that it is likely, if let alone, to burrow and to produce other mischief. The extension of pus, in such a condition, is always highly prejudicial both to the part and system, keeping up pain, favoring hectic irritation, and rapidly undermining the vital powers. When the matter has been evacuated, whether by a valvular or direct incision, the opening should immediately be closed with adhesive plaster and a thick compress, wet with oil and supported with a bandage, a full dose of morphia being at the same time injected under the skin. When the quantity of matter is unusually great, the best dressing, especially when evacuation is effected by a free opening, is an emollient cataplasm or warm water, medicated with laudanum and sugar of lead. To prevent undue reaction, the system should be steadily kept under the influence of opium, repeated not less than twice a day for at least a week, or until the parts and the system have become accustomed to their new relations. The strength is sustained by tonics and a suitable diet, pure air, and frequent ablutions of the surface with salt water.

If sinuses form, the best plan is not to interfere with them until the patient is sufficiently strong to bear the operation, as the pain and loss of blood consequent upon the use of the knife would, except in rare cases, more than counterbalance any good that might otherwise accrue. Any loose fragments of bone or cartilage should, of course, be promptly removed, and a counteropening may also frequently be beneficial. Washing out the abscess several times daily with weak solutions of chlorinated sodium, permanganate of potassium, nitrate of silver, or similar articles, is especially indicated when the matter is thin, ichorous, and fetid. When the suppurative action is in great measure subdued, the plastic deposits are best dealt with by sorbefacient plasters, as the ammoniac and mercurial, under the influence of which the induration and swelling often disappear with astonishing rapidity. When there is much pain, a suitable quantity of morphia may be incorporated with its ingredients.

In the event of a cure, whether spontaneous or artificial, passive motion must, in due time, be instituted, to prevent ankylosis. The principles upon which it should be conducted are the same as in dislocations and fractures of the joints. Much judgment, however, is necessary, otherwise the operation may readily reprovoke disease. The best plan is to repeat it, at first, only about every fourth day, until the parts have become somewhat accustomed to it, when it may be employed more frequently. As the proceeding is always very painful, especially for some time, it is very important that the patient should be anæsthetized. Indeed, without this precaution, it will be impossible to over-

come the action of the rigid and contracted muscles, or to break up the morbid adhesions in and around the joint.

When the extremities of the bones are necrosed, or so completely carious as to preclude all hope of recovery by time and ordinary means, the soft parts being riddled with sinuses, and the discharge copious and exhausting, excision of the diseased parts will be demanded, and should, if life be not too deeply undermined, be promptly performed, as most likely to rescue the patient from impending death. The disease being thus arrested, the part and system will be placed in a much better condition for gradual and permanent recovery. With proper care it may even be possible to preserve a certain degree of motion between the contiguous bones. Excision is more particularly applicable to strumous disease of the hip and shoulder joints. Good cures, however, occasionally result when the operation is performed upon some of the other joints, although I believe that amputation is always preferable when there is extensive organic lesion, and life is rapidly ebbing away from protracted suffering, or suppuration.

2. TUBERCULOSIS OF THE JOINTS OF THE HEAD AND TRUNK.

1. *Temporo-Maxillary Joint.*—It is not often that this articulation is invaded by this disease, and then almost exclusively in young persons of broken-down constitution, from the effects of cold, mercury, or irritation of the teeth. It is distinguished by a puffy swelling in front of the ear, or in the temporo-maxillary region, by tension and discoloration of the skin, and by a dull, heavy pain in the joint, increased by pressure and motion of the jaw. During the progress of the disease, the auditory canal becomes greatly diminished, if not entirely closed, and the seat of a very fetid, purulent discharge, attended with loss of hearing, especially when there is much involvement of the temporal bone. Finally, abscesses and fistulous openings form, exposing this bone and the condyle of the jaw in a carious or necrosed condition.

In the treatment of this affection special care must be taken to guard against ankylosis, otherwise, when recovery occurs, the functions of the joint may be permanently lost. Dead bone must be extracted as soon as it is sufficiently detached, and the condyle of the jaw may, if necessary, be resected, as in a case under my observation in 1874, in which I removed the condyle successfully in a girl seven years of age. When there is much involvement of the temporal bone, the patient may die from an extension of the disease to the brain.

2. *Clavicular Joints.*—The joints formed by the junction of the clavicle with the sternum and the scapula are occasionally involved in tuberculosis. The disease is met with chiefly in young subjects, and is characterized by the usual phenomena.

When it attacks the sterno-clavicular articulation, the most prominent signs are, a soft, puffy, and elastic swelling at the seat of the disease, and a fixed pain at the same point, aggravated by pressure and motion of the scapula, and also somewhat by forced inspiration and expiration. The head of the collar-bone often presents the appearance of being enlarged. In time an abscess forms, and, if its evacuation is neglected, the matter may descend into the anterior mediastinum, and thus occasion fatal consequences. Luxation of the clavicle can occur only when there is complete destruction of the connecting ligaments, permitting the end of the bone to project upwards or backwards: in the latter case it may compress the trachea and œsophagus.

Tuberculosis of the acromio-clavicular joint is very uncommon, and is characterized by the same symptoms as the preceding disease. Care should be taken not to confound these affections with rheumatism, to which both these joints are liable.

The treatment requires nothing peculiar. Resection of the clavicle may be performed if this bone is extensively necrosed, or otherwise diseased, or if it injuriously compresses the trachea and œsophagus.

3. *Occipito-Atloid and Atlo-Axoid Joints.*—Tuberculosis of these articulations, first accurately described by Schupke, in 1816, and since then specially investigated by Bérard, Teissier, and Schœnfeld, occurs principally in children and young adults, either without any assignable cause, or as a consequence of cold or injury. Although it is essentially similar to Pott's disease, it requires separate notice on account of the peculiarity of some of its effects.

The disease, whether beginning in the synovial, cartilaginous, or osseous tissue, often commits the most frightful ravages, sometimes destroying the greater part of the arch of the atlas, the whole of the odontoid process, and, perhaps, even the margins of the occip-

ital bone.   What is remarkable, the anterior portions of these structures generally suffer much more than the posterior.

In consequence of the destruction of the ligaments, the occipital bone may be dislocated forwards, backwards, or laterally, displacement by rotation being extremely rare.   In whatever direction the accident may occur, the encroachment of the parts upon the spinal canal is seldom sufficient to cause any serious compression of the cord.   The atlas is more frequently luxated than the occipital bone, being thrown either forwards or to one side. Occasionally the displacement is by rotation.   Dislocation backwards is impossible on account of the obstacle offered by the odontoid process.   In the more severe forms of the disease the displacement is sometimes of a mixed character.

The spinal cord is variously altered, according to the nature and extent of the osseous involvement.   In some cases it retains its normal structure, while in others it is softened and broken down.   The dura mater is generally thickened, engorged, fungous, ulcerated, or even perforated, and the arachnoid membrane inflamed and incrusted with lymph.

The disease, at its commencement, is characterized by a dull, aching pain, circumscribed, deep-seated, and much increased by motion and pressure.   A sense of weight and fatigue is experienced in the upper part of the neck, and the patient at length finds it difficult, if not impossible, to support his head in walking.   Gradually other symptoms supervene, the most distressing of which are pain and difficulty in deglutition, dependent upon inflammation of the pharynx.   The neck now becomes deformed, owing to the joint agency of the displacements above alluded to, and of interstitial deposits.   The posterior muscles are remarkably firm and rigid, and the head is immovably fixed, not unfrequently in a very vicious position, being either bent forwards toward the sternum, drawn backwards, or inclined to one side.   When the disease is fully developed, the pain, all along sufficiently distressing, is greatly increased in severity, and radiates about in different directions, especially up into the head and down the neck into the shoulders. When abscesses form, the patient, in addition to the dysphagia, experiences difficulty in speaking, expectorating, and breathing, in consequence of the obstruction of the fauces from the accumulating fluid, and from the same cause the tongue is sometimes partially protruded from the mouth.   The matter is discharged either into the mouth or at the back of the neck ; often by several apertures.   Occasionally large pieces of bone come away with the pus.

When the spinal cord and its membranes are seriously involved, there will be, in addition to the above symptoms, great embarrassment of respiration, lividity of the face, and paralysis, first of the superior, and afterwards of the inferior, extremities ; together, in short, with all the phenomena of a gradual but surely fatal asphyxia.   In some cases the patient perishes suddenly from an accidental twist of the neck crushing the spinal cord.

The deformity of the neck consequent upon this disease is deserving of special notice in a diagnostic point of view.   The affected part is much broader than usual, and also more protuberant or irregular.   When the occipital bone is thrown forwards upon the atlas, the depression which naturally exists at the upper part of the neck, between the attachments of the two trapezial and the two splenial muscles, is effaced, and the finger easily recognizes the posterior arch of the atlas.   If, on the contrary, the bone is forced backwards, the hollow in question will be found to be increased, and the spinous process of the axis less distinguishable.

The displacements of the atlas are generally easy of recognition.   Teissier, who has studied the subject with much care, states that when this bone is dislocated forwards, the spinous process of the axis forms a prominence more marked and nearer to the occipital protuberance than in the natural state, at the same time that the swelling is abruptly interrupted at its upper part, where it is surmounted by an excavation.   When the displacement is lateral, the spinous process of the axis will be found to be more in the direction of a vertical line, extending from the external occipital protuberance.   Finally, one of the articular processes of the axis may give way, and thus form a projection in the neck, either on the right or left side of the middle line.

Tuberculosis of these joints may be simulated by the effects of rheumatism and of external injury, causing pain and stiffness of the neck, with partial, if not complete, immobility of the head.   When the disease is far advanced, the diagnosis is unequivocal.

When recovery takes place, the neck generally remains deformed and protuberant, with great impairment of its functions, the affected bones being completely soldered together by new osseous matter.

In the treatment of this affection, in addition to the employment of the usual remedies, rest and support of the part, by suitable apparatus, are most important elements. The head should lie on a level with the trunk, with a thin, elastic pillow under the neck, and care should be taken, especially in the more advanced stages of the complaint, that it is not suddenly moved in any direction, lest, the ligaments having given way, the bones should become displaced, and thus instantly and fatally crush the spinal cord. The recumbency must be steady and protracted. A circular issue should be established, at an early period, with the actual cautery, directly over the diseased joints, and a free discharge of matter invited. Advancing abscesses should be promptly opened, in particular if they point toward the fauces; if neglected, they may suffocate the patient by their pressure upon the mouth of the larynx, or, bursting unexpectedly, the matter may pass into the windpipe, and so induce fatal asphyxia. If an attempt at reposition of the dislocated bones should be deemed advisable, the operation must be performed with the greatest possible care and gentleness. In the event of recovery, the neck and head must be supported for a long time by a proper appliance, to afford the parts a proper opportunity for safe and perfect consolidation.

4. *Sacro-Iliac Joint.*—The sacro-iliac joint is liable to a very rare form of strumous disease, analogous to coxalgia and white swelling of the knee. It was first accurately described by Boyer, and very excellent accounts of it have been given by Hahn, Nélaton, Erichsen, and Boissarie.

The disease, which is essentially chronic, is most common between the ages of twelve and thirty. Infants seem to be entirely exempt from it. The statistics of Dr. C. T. Poore, of New York, show that children and adults are alike subject to it. Its causes are the same as those of scrofulous affections in general. In the great majority of cases the lesion comes on spontaneously; but an instance now and then occurs in which it is traceable to direct violence, as a blow, kick, fall, or sprain, to the effects of cold, or to suppression of the cutaneous perspiration. Injury done to the pelvic bones and joints during pregnancy and parturition probably predisposes to its production, especially when there is a strong strumous diathesis. Certain occupations may also possibly favor its development. Thus, Hahn has narrated three cases, all occurring in tailors.

The pathology of the disease is sufficiently well understood. Whatever the nature of the exciting cause may be, struma is unquestionably its intrinsic element. In its earlier stages, the disorder is generally limited to the synovial and cartilaginous structures of the sacro-iliac symphysis, these structures becoming eroded, and eventually broken down into a softened, pultaceous substance, presenting a condition not unlike what occurs in the so-called pulpy degeneration of strumous joints, especially that of the knee. As the morbid action progresses, the osseous tissues also suffer, as is evinced by their rough and denuded appearance, by their abnormal vascularity, and by their infiltrated, spongy, and disintegrated character. Caries and necrosis are, however, seldom met with, even in very chronic cases, and the ligaments also retain for a long time their integrity.

The most important *symptoms* are, pain, swelling, lameness, and deformity of the pelvis and limb. To these are superadded, in time, abscesses and sinuses, along with hectic fever, which is generally a prominent occurrence.

Pain is an early symptom; it is seated in the course of the sacro-iliac symphysis, is increased by pressure and motion, and is accompanied by a sense of weakness in the lower part of the back and sacrum. The patient feels as if he would drop apart, and finds it extremely difficult to support himself in walking, very much as in sciatica or rheumatism, for which, at this stage, the disorder is often mistaken. As the disease advances, the pain becomes more fixed and severe, and assumes a dull, aching, or gnawing character. It does not, except in rare instances, extend down the limb, nor is it aggravated by moving the thigh, unless the surgeon neglects to steady the pelvis, when it is often very severe. The gluteal region is somewhat flattened, and tender on pressure, especially as the finger approaches the seat of the disease.

The swelling, originally very slight, gradually increases in extent, and, in time, becomes a prominent feature. It is puffy, elongated from above downwards, and situated in the line of the affected joint; not materially involving the gluteal region, nor invading the natural hollow behind the great trochanter. When abscesses occur, the form and size of the swelling are greatly changed.

Lameness is an early and prominent symptom. The patient, at first, merely limps, and is soon fatigued by exercise. In a very short time, however, his movements become much constrained, and he supports himself with great difficulty, leans forward, and

employs a cane or crutch.   He can put his foot on the ground, but is unable to bear his weight upon it, nor can he twist himself suddenly around without great suffering.   At length his locomotive powers are completely crippled, and he is obliged to keep his bed. Pressure upon the iliac bone, or pushing this bone forcibly against the sacrum, always causes severe pain.

The limb on the corresponding side is, from the very first, longer than the other, the increase in length varying from six lines to an inch or even an inch and a half, according to the duration and violence of the morbid action.   The change, however, is not real, but, as in coxalgia, merely feigned, depending upon the alteration in the position of the pelvis, which is not only considerably depressed, or lower than on the sound side, but also tilted forwards and rotated downwards so as to impart an unusual degree of prominence to the anterior superior spinous process of the ilium.   The limb itself is attenuated, flabby, and enfeebled.   In progression, it is generally somewhat abducted, flexed at the knee, and projected a little forwards, the weight of the body being thrown entirely upon the sound side.   Upon taking hold of the limb, it can be moved in any direction.

By and by, after months of suffering, sometimes, indeed, not until after a year or a year and a half, matter begins to form, preceded by an increase of local and constitutional disturbance, ultimately eventuating in severe hectic irritation.   The swelling over the joint gradually increases in size, and the fluid, which is always of a scrofulous character, slowly burrows among the neighboring parts, spreading underneath the gluteal muscles, in the direction of the great trochanter, extending into the loin or passing into the pelvis, by the side of the rectum, or the rectum and vagina, in the former of which it occasionally finds an outlet.   When this is the case, flatus may enter the cavity of the abscess, and so cause it to become tympanitic.   Sometimes the matter, after having passed into the pelvis, issues at the sciatic notch, and thus gets, as has been observed by Mr. Erichsen, under the gluteal muscles.

The affections with which sacro-iliac disease is most liable to be confounded are, coxalgia, neuralgia of the hip, sciatica, and caries of the spine.   From coxalgia it is distinguished, 1st, by the peculiar shape and site of the swelling ; 2dly, by the character and situation of the pain, which does not affect the limb or knee, as in hip-joint disease ; 3dly, by the tardy progress of the morbid action ; 4thly, by the rotated appearance of the pelvis and the abnormal prominence of the anterior superior spinous process of the ilium ; 5thly, by the persistence of the ilio-femoral crease ; 6thly, by the preservation of the movements of the hip-joint ; and, lastly, by the suffering which the patient experiences when firm pressure or percussion is applied to the innominate bones.   In sacro-iliac disease considerable pain is sometimes perceived at the upper and inner part of the thigh, from involvement of the obturator nerve in its passage through the pelvis.   In both affections there is shortening of the limb, but in the sacro-iliac it is never real at any time, while it is invariably so in the latter stages of coxalgia, owing to the partial destruction of the head and neck of the femur.   Coxalgia is nearly always a disease of early childhood, whereas sacro-iliac disease is seldom observed until after the fifteenth year.

Neuralgia of the hip occurs chiefly in young females of a nervous temperament and hysterical habits, and is, generally, easily distinguished from disease of the sacro-iliac synchondrosis, first, by the character of the pain, which is more widely diffused, as well as more superficial and irregular ; secondly, by the want of intumescence in the course of the joint ; thirdly, by the coexistence of neuralgia in other parts of the body ; and, fourthly, by the history of the case.   Another important element is the absence of abscess, which nearly always occurs in the latter stages of sacro-iliac disease.

The discrimination between sciatica and this affection is seldom difficult.   The chief signs of distinction are that, in the former, the pain is confined chiefly to the lumbar region, while in the latter it is seated more particularly in the line of the sacro-iliac joint. Besides, it is generally more easily amenable to treatment, and is very frequently connected with a gouty or rheumatico-gouty state of the system.   Moreover, in sciatica there is no deformity of the pelvis or change in the length of the limb.

It is barely possible that sacro-iliac disease might be confounded with disease of the spine ; but such an occurrence will readily be avoided if the surgeon keep clearly before his mind the distinction between the real symptoms of the two disorders.   In the former there is always more or less intumescence in the line of the sacro-iliac joint, with marked deformity of the pelvis and elongation of the limb on the affected side ; in the latter all these phenomena are wanting, and the vertebral column is stiff, tender on pressure, and excurvated.   The most common site of the disease is the dorsal portion of the spine, and, if an abscess form, the matter never gravitates in the direction of the sacro-iliac junction.

The prognosis is favorable in the early stage of the disease, and a cure is not infrequent even when matter has formed. Of 58 cases, collected by Poore, 23 recovered; and of 18 in the hands of Sayre, in 6 of which dead bone was removed, all, save one, were restored to health. When the treatment has been neglected, the patient, after having lingered for months, with an occasional intermission from suffering, is finally worn out by the profuse drain and hectic irritation, or by some intercurrent disease, as purulent infection, or tuberculosis of the lungs.

The *treatment* of sacro-iliac disease is similar to that of coxalgia. The principal remedies are rest, recumbency, and confinement of the pelvis, with leeches, iodine, and blisters in the early stages of the disorder, followed, if there be not prompt and decided amelioration, by the establishment of a long issue, with the actual cautery, in the line of the affected joint. Of course, no severe counterirritation is admissible after the parts have become seriously disorganized. If abscesses form, no time must be lost in letting out their contents by a valvular incision. The strength is supported by tonics, and the constitution improved by alterants, as iodide of iron, iodide of potassium, and bichloride of mercury, with cod-liver oil and other suitable means.

Professor McGuire, of Richmond, in 1878, reported two cases of this disease in which great and immediate relief, and, finally, a perfect cure followed the employment of extension and counterextension, conducted upon the same principles as in the treatment of fractures. No counterirritation was used.

3. TUBERCULOSIS OF THE JOINTS OF THE SUPERIOR EXTREMITY.

1. *Wrist-joint.*—The characteristic features of tuberculosis of the wrist-joint are well depicted in the annexed engraving, fig. 604, from Barwell, the disease having already made considerable progress. It will be observed that the greatest amount of swelling and distortion is on the dorsal surface of the hand, although there is also a good deal of fullness in front and in the hollow of the palm, which is often completely effaced, especially when the matter gravitates in that direction. The thumb and fingers are tumefied, stiff, and straight, or nearly so, and have a peculiarly elongated appearance. Every attempt to move them excites severe

Fig. 604.

Tuberculosis of the Wrist-joint.

pain, or pain and spasm. A sense of fluctuation, often very faint and perplexing, is usually perceptible, being most distinct on the back of the joint, and caused either by a fungous condition of the synovial membrane, or by the presence of an unnatural quantity of synovial fluid, or both. The muscles of the limb are wasted and flabby. If matter form, it generally experiences not only great difficulty in finding an outlet, but is very apt to travel up the forearm and down along the dorsal surface of the hand. Dislocation of the bones, in any direction, is uncommon. The head of the ulna, however, is often abnormally prominent, but of the radius the styloid process alone is distinguishable.

The treatment consists in placing the limb in an easy, straight position upon a carved splint furnished with appliances for keeping up extension and counterextension, and in employing the various measures called for in tuberculosis of other joints. If matter form, an early outlet must be afforded, lest it diffuse itself extensively among the soft parts and the bones, and so endanger limb and life. Although resection is sometimes available, the preference should generally be given to amputation.

2. *Elbow-joint.*—Tuberculosis of this joint generally begins in the structures of the humerus, whence it may gradually spread to the ulna and radius, and finally involve the whole articulation. Pain, stiffness, and swelling in and around the joint are the prominent symptoms of the disease. The skin is tense, glossy, and more or less red at the focus of the morbid action; the parts are intolerant of manipulation and motion, and the swelling presents itself in the form of two cones, united on a level with the crease of the elbow, one apex looking upwards, the other downwards. The osseous prominences are completely effaced, except that formed by the olecranon process, on each side of which there is usually a good deal of fluctuation, caused by the presence of a large quantity of synovial fluid. The limb is wasted both above and below the joint, and the fingers are stiff, swollen, and almost useless. The biceps muscle is rigidly contracted, so as to render extension difficult, if not impossible, and the forearm is bent nearly at a right angle with

the arm.   When matter forms, it is usually discharged at the back part of the joint, at the side of the olecranon process, or at the lower part of the arm; seldom in the forearm or in front of the joint. The ulna, owing to the solidity of its connections, is hardly ever dislocated, but it is not uncommon for the radius to abandon its relations with the humerus when there is much disorganization of their ligaments.   In the worst forms of the disease, the bones are involved to a great extent; far, indeed, beyond their articular extremities.

In the treatment of this affection the same principles are to be observed as in articular tuberculosis in general.   Early recourse should be had to the actual cautery, drawn linearly along each side of the joint for three or four inches, and to proper support by means of a suitable splint, extending from near the axilla down to the fingers. The forearm should be placed in a semiflexed position; matter should be promptly evacuated, and every means employed to preserve the usefulness of the limb.   Amputation will be necessary when the disease is very extensive, or the general health is much impaired; otherwise the affected bones may be advantageously dealt with by resection.

3. *Shoulder-joint.*—Tuberculosis of this joint is uncommon, and is met with chiefly in young persons after the age of eighteen or twenty, beginning generally in the synovial membrane and other structures of the humerus, to which it is nearly always limited, the glenoid cavity of the scapula rarely suffering.

The disease is usually announced by more or less swelling, pain, and stiffness in the joint, which the patient is generally disposed to ascribe to the effects of rheumatism, cold, or some slight injury.   As it progresses, the shoulder loses its natural contour, and assumes a peculiarly rounded appearance, owing to the presence of an undue quantity of synovial fluid.   The deltoid muscle is gradually flattened and atrophied, and, in fact, the whole arm is wasted.   The movements of the joint, at first merely restrained, are ultimately entirely lost.   If the morbid action is not arrested, abscesses at length form, point and break, leaving thus a number of fistulous openings leading down to the diseased bone, which is either carious or both carious and necrosed, not unfrequently to an extent of three or four inches.   In the worst cases, there is sometimes serious involvement of the glenoid cavity of the scapula.

The pain which attends this disease, early in the attack, is occasionally most keenly felt in the elbow, as in coxalgia it is originally seated in the knee.   Such an occurrence is, however, uncommon, and, therefore, of little diagnostic value.

The treatment consists in complete repose of the joint, and in the application of leeches and blisters, or, if the attack is obstinate, the hot iron.   Matter is early evacuated, and dead bone or cartilage removed as soon as it is sufficiently detached.   In protracted cases, dependent upon the presence of carious or necrosed bone, the proper remedy is excision; an operation which, if carefully executed, is not only free from danger, but nearly always successful, the patient regaining a good use of his limb.

4. TUBERCULOSIS OF THE JOINTS OF THE INFERIOR EXTREMITY.

1. *Ankle-joint.*—The most common cause of tuberculosis of this joint is external injury, as a sprain, twist, blow, or contusion.   Among the earlier local symptoms is a swelling just in front of each malleolus, filling up the hollow which naturally exists there; it fluctuates under the finger, and is mainly dependent upon the presence of synovial fluid, which, from the peculiar structure of the joint, always accumulates there in larger quantity than elsewhere.   As the disease progresses, the grooves at the side of the tendo Achillis disappear, and the whole joint becomes enormously enlarged, the heel and other osseous prominences losing their distinctive features.   This increase of size is owing, not exclusively to morbid deposits in and around the articulation, but also, at least in part, to an expansion of the ends of the bones, as is easily ascertainable by examination. When the disease is far advanced, the fluctuation is rendered very faint in consequence of the fungous condition of the synovial membrane, the leg is excessively wasted, and the foot has a distorted or twisted appearance, as if it were rotated upon its axis, or partially dislocated.   If suppuration takes place, the matter usually collects in front of the joint, diffusing itself more or less extensively in the subcutaneous connective tissue of that region.

In the treatment of this disease, the foot should be placed at a right angle with the leg, and the parts well supported with suitable splints, so as to maintain them in an easy, relaxed, and quiet position.   Linear cauterization may be performed; or, what is preferable, a small issue should be established with the hot iron immediately above each malleolus.

Prompt vent is afforded to pus ; and, if the joint cannot be saved, resection or amputation is resorted to, according to the judgment of the surgeon.

2. *Knee-joint.*—This joint, owing to the great size of its articular surfaces, its extensive motions, and its exposed situation, is, next to the hip, more frequently the seat of tuberculosis than any other joint in the body. While the disease is most common in young persons before the age of fifteen, it is often met with in young adults, and is generally developed under the influence of external violence, as a blow, fall, or twist, acting upon a depraved constitution.

The pain which attends this disease, and which is generally very severe, even at the commencement of the attack, is almost invariably situated in the direction of the inner condyle of the femur, at the lower part of the patella, or at the inside of the head of the tibia ; seldom at the outer part of the joint. The great uniformity of this occurrence has led to various speculations as to its course, but, as yet, no satisfactory explanation has been offered. As in coxalgia, the pain is liable to periodical exacerbations ; in general, it is of a dull, heavy, gnawing character, and is commonly worse at night than in the day, extending up and down the limb, and destroying the patient's sleep and appetite.

The concomitant swelling is usually very great, and is due partly to interstitial deposits, partly to an inordinate increase of the synovial fluid. It is always most conspicuous, especially in the earlier stages of the complaint, in front and at the sides of the patella, owing to the laxity and yielding character of the tissues at these points. It is in consequence of this circumstance that the depressions in this situation are generally soon completely effaced, or, what is the same thing, replaced by soft, fluctuating bags. A similar prominence, often of great size, exists just above the joint, over the lower part of the femur, bounded inferiorly by the patella, and on each side by the lateral ligament, its anterior wall being formed by the tendon of the extensor muscle. Very little tumefaction ever occurs in the popliteal region, even in the more advanced stages of the disease. The skin is tense and glossy ; the subcutaneous veins are abnormally large ; the knee is stiff, if not immovable ; and the leg, more or less flexed, is swollen and œdematous, while the thigh is remarkably atrophied. In proportion as the ligaments yield, the deformity of the joint increases, owing chiefly to the displacement of the head of the tibia, which allows the muscles to draw the leg outwards, so as to give it a twisted or contorted appearance. Not unfrequently there is an actual enlargement of the heads of the diseased bones.

The fluctuation which constitutes so prominent a symptom in the earlier periods of this complaint, often, in great measure, if not entirely, disappears during its progress, owing to the adventitious deposits upon the synovial membrane and the absorption of the redundant synovial fluid. Whenever this is the case, the swelling, instead of being soft and yielding, will be comparatively firm and resisting, but still possess some degree of elasticity, often so deceptive as to lead to the idea that the joint contains a good deal of fluid, and which nothing but the most careful examination can dispel.

Pus does not always form in this disease, even when permitted to proceed unmolested ; on the contrary, there is reason to believe that it is frequently entirely absent. When suppuration does take place, the matter may either be absorbed, or it may escape at the side of the patella, the lower part of the thigh, or over the head of the tibia ; very rarely in the ham. In the worst forms of the disease, the whole surface of the joint may be riddled with fistulous apertures, leading down to the diseased bones, large portions of which are then either carious or necrosed.

The *treatment* of tuberculosis of the knee presents nothing peculiar. The same rules of practice are to be enforced here as in coxalgia. Rest of the part and system, local support and extension by means of splints and the weight and pulley, and cauterization, either linear or circumscribed, are of primary importance, and must be thoroughly enforced from the very beginning.

When the more acute symptoms have subsided, or the disease has assumed a chronic form, to enable the patient to exercise in the open air, the requisite extension and rest of the joint may be secured by the apparatus of Dr. Sayre, delineated in fig. 605. It consists of two steel collars, each about one inch wide, which embrace the limb—the one at the upper third of the thigh, the other just above the ankle—and admit of adjustment by means of a sliding hinge and lock, while they are connected on each side by an extension rod, constructed on the rack and pinion principle. To apply this instrument, strips of strong, inelastic adhesive plaster, one inch in width, are arranged on the limb in the manner represented in fig. 606, and confined to within an inch of their extremities by a roller.

The instrument is then placed in position, the collars fastened sufficiently tight to be comfortable, and the free ends of the plaster turned over them and secured by a roller. The connecting rods are extended simultaneously by means of the thumb-screws, the limb being thus brought nearly into a straight line, as in fig. 607, freedom from pain, on pres-

Fig. 605.
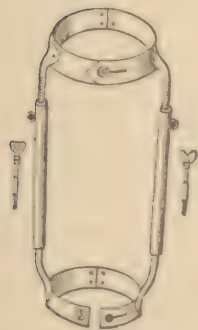
Fig. 606.

Fig. 607.

Sayre's Apparatus for Extension
at the Knee-joint.
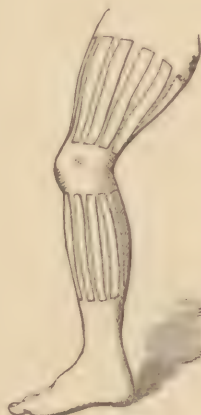
Mode of applying the Adhesive
Plaster.
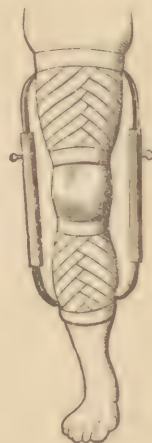
Apparatus Adjusted.

sure being brought to bear on the foot, denoting that the requisite degree of extension has been effected. The dressing is completed by enveloping the leg in a bandage from the toes up to the top of the instrument, to prevent swelling, and by surrounding the joint with strips of gum ammoniac and mercurial plaster, so as to exert a sorbefacient action upon the swollen and pulpified tissues. When the parts are hot and painful, the application of the plaster should be preceded by saturnine and anodyne lotions.

When, so far as ordinary treatment is concerned, the case is hopeless, the only resource is resection of the affected joint; or, this being inadmissible on account of the great extent of the disease, amputation of the thigh, which will make a better and more satisfactory cure.

3. *Hip-joint.*—Tuberculosis of this articulation, usually called coxalgia, femoro-coxalgia, or hip-joint disease, is most frequent from the third to the seventh year. Cases occasionally occur before the twelfth month, and now and then an instance is seen after puberty, or even after the age of twenty, but this is uncommon. The oldest case that I have ever witnessed was that of a man twenty-six years of age. Of 1818 cases, analyzed by Dr. V. P. Gibney with reference to this subject, 1602, or 88¼ per cent. were under fourteen years. Both sexes are liable to it, probably nearly, if not quite, in an equal degree, at least such would seem to have been the fact in the cases analyzed by Dr. Gibney; the affection has sometimes been noticed in several members of the same family.

The causes of coxalgia are the same as those which provoke strumous disease in other parts of the body. The most common are external injury, as sprains, falls, or blows, exposure to cold, inadequate food and clothing, and wasting maladies, as cholera, chronic diarrhœa, dysentery, scarlatina, measles, and different kinds of fevers. In many cases it arises spontaneously, or without any obvious causes.

It is seldom that both hip-joints are involved in this affection, either simultaneously or successively. During its progress, however, it becomes occasionally complicated with other strumous maladies, as Pott's disease of the spine, psoas abscess, ophthalmitis, pulmonary phthisis, and degeneration of the lymphatic glands of the neck, mesentery, and other parts of the body.

It is seldom in the power of the surgeon to ascertain the starting point of this disease, as few opportunities occur for examining the parts in the earlier stages of the morbid action. Nevertheless, enough is known to show that the articular cartilage of the head of the femur is the structure which most generally suffers first. In some cases the disease undoubtedly begins in the synovial membrane, in the interarticular or capsular ligament, in the acetabulum, or even in the cancellated tissue of the femur or ilium. However this may be, all the component elements of the joint become sooner or later involved in the disorganiza-

tion, the disease extending from one structure to another, although probably not with equal facility or rapidity.

Symptomatology.—Tuberculosis of the hip-joint may be described as consisting of three stages, each characterized by distinctive symptoms and pathological changes, as well as requiring peculiar treatment. As this division is not imaginary, but real, it is deserving of the greatest attention.

The symptoms of the disease, in its *first stage*, are usually of so obscure and stealthy a character as to render it very liable to be mistaken for other affections of the joint. The first circumstance which commonly attracts attention, especially if the patient is a child, is a feeling of fatigue after exercise, with slight pain in the knee, and a disposition to drag the limb, thus giving the gait a stiff, awkward appearance. In this manner the case may progress for several weeks, or, indeed, even for several months, with, perhaps, hardly any perceptible aggravation. The child still goes about, taking his accustomed exercise, and manifesting the same interest as formerly in his out-door amusements. Gradually, however, the pain increases; there is now a distinct limp; and the sleep is disturbed by spasmodic twitches of the extremity. The pain is usually referred to the knee, particularly to its inner side, and is either sharp and lancinating, or dull, heavy, and aching. It is sometimes felt in the very depths of the joint, but more frequently it is superficial, as if it were immediately beneath the integument. Exercise, or motion of any kind, always increases it, and it is generally worse at night than in the day; damp states of the atmosphere, suppression of the cutaneous perspiration, and disorder of the digestive organs, also frequently aggravate it. The knee, on inspection, is found to be free from swelling and discoloration, and commonly quite tolerant of rough manipulation, as motion, pressure, and percussion. Occasionally the pain is of a neuralgic nature, and distinctly periodical in its recurrence, very similar, in this respect, to the paroxysms of an intermittent fever: the attack, perhaps, coming on early in the evening, and, after having continued for a few hours, returning about the same time next day. This form of pain is most frequent, according to my observation, in persons living in a malarial atmosphere.

It is not often, however, that the pain, whatever may be its character, is entirely confined, at this stage of the disease, to the knee; or, if it is at first, that it remains there exclusively for any length of time. In general, it extends also to the thigh and leg, sometimes along the front, now along the sides, especially the inner, and now along the posterior surface, in the direction, apparently, of some nervous trunk, as the femoral, obturator, saphenous, or sciatic. I have met with cases where the pain was felt most keenly at the tendo Achillis, immediately above the ankle-joint, and in one instance it was distressingly severe over the instep. Sometimes, again, it seems to shift from one of these points to another, being, perhaps, most violent at one period in the knee, and at another in the thigh, leg, or foot.

The occurrence of pain in the knee may be explained by the irritation of the nerves that are distributed to the hip-joint. Thus, the round ligament receives a filament from the obturator nerve, which sends a branch to the inner side of the knee as well as to its interior. Inflammation of the synovial covering of the ligament necessarily involves its nervous supply, and the sensation of pain is experienced either at the inner side of the knee or in the interior of the joint. When the anterior portion of the capsule and its synovial membrane are primarily affected, the suffering is generally referred to the outer side of the knee, as branches are distributed to that locality from the femoral nerve, which also sends articular branches to the front of the hip-joint. Anomalous pains experienced at other situations may also be explained by nervous irritation. The posterior portion of the hip-joint is supplied by filaments from the great sciatic trunk, which sends branches not only to the back of the knee, but to the entire lower extremity, so that pain may be felt at any of the points supplied by that nerve, when the inflammation is seated at the posterior surface of the articulation. A knowledge of these anatomical facts renders great aid in the diagnosis of individual cases, and serves to prevent those curious mistakes, which not unfrequently occur, of medicating parts which are free from disease.

After some time, varying from a few weeks to as many months, the pain shifts to the hip and its neighborhood; or, if it do not entirely forsake the knee, it is generally less constant and severe there than it was in the first instance, or soon after the commencement of the morbid action. Commonly it is most intense and persistent directly over the articulation, deep-seated, and of a dull, gnawing character. At times it is perceived most keenly in the sciatic notch, between the great trochanter and the spine of the ilium, or in the upper and outer part of the groin. Occasionally, again, it exists simultaneously at all these points, although not in an equal degree; or, as it leaves one, it fastens itself upon

another. In rare cases the pain appears in the hip before it shows itself in the knee, thigh, or leg. Pressure upon the gluteal region and the groin, motion of the affected joint, and percussion of the knee, the leg being flexed at a right angle, or of the sole of the foot, the limb being extended, always augment the pain, and lead to the detection of its seat.

As yet, there is no sensible impairment of the general health; the appetite is good, and the various tissues retain their normal condition. The muscles of the affected hip and limb are, perhaps, a little thinner and softer than natural, but these changes are usually slight, and hence they often elude detection.

In the *second stage* of the complaint, the most prominent local phenomena are, an increase of pain in the hip and knee, flattening of the buttock, effacement of the gluteo-femoral crease, abduction, outward rotation, and apparent elongation of the limb, with spasmodic twitching and wasting of its muscles.

The pain, hitherto seated chiefly in the knee, now also affects the hip, or, if it existed there previously, as, indeed, is not unfrequently the case, it becomes sensibly aggravated. It is particularly violent at night, often for hours interrupting sleep, and is attended with the most distressing spasmodic twitches of the muscles of the limb, which thus greatly augment the local and general suffering by the sudden and forcible apposition of the inflamed articular surfaces. The pain at one time is fixed, deep, aching, gnawing, or boring; at another, erratic, sharp, or lancinating, darting about in different directions, now through the joint, then down the limb, and then through the groin, or back along the course of the sciatic nerve. It is most distressing when the bone is inflamed immediately beneath the articular layer, and sets in much earlier than when the synovial membrane is primarily affected, thereby furnishing a clue to the diagnosis as to which of these structures is first involved. Occasionally it is most severe in the lumbar region, in the lower part of the pelvis, in the situation of the acetabulum, or at the upper and inner part of the thigh. Sometimes, as before remarked, it is of a neuralgic character, coming, going, and recurring at particular periods. Derangement of the digestive apparatus, exposure to cold, and damp states of the atmosphere, have a tendency to aggravate and protract it. The pain in the knee, instead of disappearing, generally increases in violence, at the same time that it becomes more frequent and fixed.

Fig. 608.

The sleep is habitually disturbed by unpleasant dreams, and the patient often wakes up in great alarm, crying and screaming. Occasionally he is partially delirious from pain and fever. He sleeps by snatches, and usually feels fatigued and unrefreshed in the morning. Spasmodic twitching, jerking, or starting of the limb is a prominent symptom, seldom entirely absent in any case. Sometimes, indeed, it sets in at a very early period, and continues, with more or less violence, during the whole progress of the malady. It is particularly distressing in the muscles of the thigh, but often affects also those of the hip and leg.

Along with these symptoms there is frequently loss of appetite, with disorder of the secretions, and more or less fever at night. The bowels are usually inclined to be constipated, the urine is scanty and high-colored, the skin is rather arid, especially in the evening, and there is often considerable thirst. As the disease advances, the fever increases, and is frequently followed by copious sweats. The patient loses flesh and strength, he is peevish and irritable, and his countenance has a care-worn appearance. Although such is ordinarily the state of the system, in the second stage, especially after the disease has made considerable progress, yet there are cases in which there is hardly any constitutional disturbance whatever, except what results from the want of sleep.

The local phenomena at this stage of the malady are unmistakable. The buttock of the affected side is found to be remarkably flattened, as is shown in fig. 608, so as to be in striking contrast with the sound one. It is much broader, as well as considerably longer, than in the natural state; the gluteal muscles are soft and flabby, and the skin is preternaturally loose, from the absorption of the subcutaneous fat. The gluteo-femoral crease, so

Appearance of the Nates and Limb in Hip-joint Disease, in its Earlier Stages.

prominent in the natural state, is completely effaced, giving the thigh and hip an appear-

ance of continuity, as if they were fused together, and the internatal fold is inclined towards the affected side. The muscles of the thigh and leg are also wasted, and, in fact, the whole limb is very sensibly attenuated, evidently owing to want of exercise and perverted nervous action, leading to atrophy of their substance.

Marked elongation of the corresponding limb, with abduction and outward rotation, now exists, and is so constant an occurrence that it may, along with several of the other symptoms above described, be considered as pathognomonic. The extent of the elongation varies, on an average, from half an inch to an inch and a half. In rare cases it may amount to two inches, and even two inches and a half. It is observed both in the erect and in the recumbent posture, but is commonly more conspicuous in the former than in the latter. Several explanations have been offered of this phenomenon, all, at first sight, more or less plausible. Thus, it has been attributed to the presence of an unusual quantity of synovial fluid, the product of inflammatory action, by which the head of the thigh-bone is partially pressed out of its socket, and the corresponding limb projected beyond the level of the sound one; but that this theory is not true is proved by the fact that there are frequently large accumulations of this kind in other joints, as the elbow and knee, without producing any such effect. That it is due to a relaxed condition of the ligaments and muscles of the joint is also, I am persuaded, an unfounded idea. A third opinion, and, in my judgment, the only correct one, is that the elongation is due to the position of the pelvis, which, through the agency of the abductor muscles of the thigh, is thrown downwards and forwards, thereby producing a difference in the level of the two hips, that of the affected side being always lower than that of the sound side.

Finally, there is generally, in this stage of hip-joint disease, a marked depression, or hollow, in the lumbar region, with a slight inclination of this portion of the spine toward the sound side, and an unusual prominence of the belly. The inferior portion of the spinal groove is also more distinct than natural.

In the *third stage* the nature of the disease is no longer doubtful, whatever it may have been previously. The symptoms are characteristic of the extensive and frightful mischief that has been effected within the joint. Matter now forms, and, by its pressure upon the inflamed structures, greatly aggravates the suffering. The suppuration is indicated by an increase of pain; by a sense of throbbing and tension, deep and persistent; by severe swelling of the gluteal region, generally most prominent at the centre of the articulation; by œdema of the subcutaneous connective tissue; and by a remarkably turgid and enlarged condition of the subcutaneous veins. The affected joint is intolerant of the slightest motion or manipulation, and the patient is unable to raise himself up or turn in bed without the greatest agony. Every attempt to flex or extend the limb is attended with similar results. The constitutional disturbance is always in proportion to the local suffering, and violent rigors, followed by high fever and copious sweats, are rarely absent. Sometimes, however, the abscess forms in a quiet and insidious manner, without any of the severe symptoms that usually accompany the suppurative process in this and other varieties of inflammation. As the matter increases in quantity it gradually works its way towards the nearest surface, its approach being denoted by the occurrence of a circumscribed, erysipelatous blush. Here there is generally distinct fluctuation, and the parts, feeling soft and boggy, soon yield at one or more points, followed by the escape of the contents of the sac.

The site at which the matter, when left to itself, obtains a vent, varies in different cases. Most generally it escapes at the gluteal region, either directly over the joint, or in its immediate vicinity. The other situations at which it is most liable to discharge itself are the upper and back part of the thigh, a short distance below the great trochanter, the superior and external part of the groin, the sciatic notch, and the upper and inner surface of the thigh. Occasionally it escapes at several points, either simultaneously or successively, leaving thus a number of orifices, with a corresponding number of sinuses. These passages are sometimes very long and tortuous, and in old cases are always lined by a false membrane. I recollect one instance in which there were nine distinct openings, and another in which there were as many as twelve; two at the upper part of the thigh, and one just below the crest of the ilium, the remainder being scattered over the gluteal region.

The matter sometimes escapes both externally and internally. When the bottom of the acetabulum is perforated, it may pass into the rectum, bladder, or vagina; or, instead of this, it may collect in a sort of pouch, between the inner surface of the iliac bone and the soft parts of the pelvis.

The changes in the limb and hip, represented in fig. 609, in this stage of the disease, are striking and characteristic. The extremity, now actually shorter than natural, is much attenuated from the wasting of its fatty and muscular tissues, and remarkably disfigured in its appearance, the heel being considerably elevated, and the ball of the foot and toes alone touching the ground when the patient makes an effort to stand. The degree of shortening is variable, and not always by any means in proportion to the destruction of the head and neck of the thigh-bone, the acetabulum, and the connecting ligaments, which forms so prominent a feature of the disease at this period. While in some instances it does not exceed an inch, or, at most, an inch and a quarter, in others it amounts to twice and even thrice that extent. One-third, and sometimes even one-half of this, as I have satisfied myself by careful examination, is generally attributable to the elevation of the pelvis on the affected side. The position of the foot is variable. Sometimes it looks directly forwards or outwards, but much more commonly it inclines inwards. These differences are due to the nature and extent of the ravages experienced by the hip-joint. When the acetabulum has suffered most severely, the foot usually turns more or less out; if, on the contrary, there has been much destruction of the head and neck of the femur, and the cotyloid cavity is only slightly involved, the limb generally inclines strongly inwards, as in traumatic iliac luxations.

Fig. 609.

Shortening, Swelling, and Characteristic Deformity of the Advanced Stage of Coxalgia.

The thigh is generally bent upon the pelvis, the angle of flexion varying from the slightest perceptible change to 45°. In most cases it inclines somewhat towards the sound limb, and occasionally, although rarely, it overlaps or crosses it. Sometimes, on the other hand, it stands off widely and in a most unseemly manner from its fellow, as in the case of one of my patients, a woman, aged twenty-five, in whom the knees were habitually upwards of fifteen inches apart, the affected thigh forming a right angle with the pelvis, while the foot, in the erect position, was at least six inches from the floor.

The thigh, moreover, is always in a painfully rigid state, depending upon the contracted condition of the muscles of the hip and limb, and the formation of adhesions between the remnants of the superior extremity of the femur and the surrounding parts. By taking hold of the knee, a slight degree of flexion may, perhaps, be produced, but to abduct the thigh, or to move it backwards, is generally impracticable; besides, every effort of the kind is attended with excruciating suffering. Owing to the shortening of the hamstring muscles, the leg is commonly bent on the thigh, and, for the same reason, the flexor muscles usually draw the heel upwards towards the leg. In all confirmed cases of hip-joint disease, there is invariably a compensating curve in the lumbar or dorso-lumbar portion of the spine, caused by the manner in which the patient holds himself in sitting and walking.

The great trochanter generally lies directly over the acetabulum, or in its immediate vicinity, forming a hard, firm, immovable, or nearly immovable, prominence, the nature of which cannot be mistaken. In regard to the head and neck of the femur, they are, as stated elsewhere, usually completely annihilated, or so much wasted as to exist only in a rudimentary form. It has generally been alleged that there is, in this stage of the disease, more or less displacement of this bone; but the facts collected by the late Dr. March, of Albany, in the extensive museums of the United States and of Europe, as well as in private practice, conclusively prove that dislocation of the femur, as a consequence of this affection, in any direction, is exceedingly rare. A true luxation, such as occurs in the normal state of the parts from injury, is, in fact, impossible, from the very nature of the morbid alterations in the superior extremity of this bone. During the progress of the disease, the remnant of the neck, which is usually of a rounded, conical shape, and frequently not more than three-quarters of an inch in length, ordinarily places itself over the acetabulum, to the margins of which, and to the adjacent parts, it becomes, in the event of recovery, ultimately united. That it is occasionally drawn up beyond this point, especially when there has been complete destruction of the upper border of the acetabu-

lum, backwards towards the sciatic notch, forwards upon the pubic bone, or downwards and forwards into the thyroid foramen, is unquestionable. Dislocation, however, in most of these directions, can only take place in those cases where there has been extensive suppuration, with separation or destruction of the soft parts, allowing the superior extremity of the bone to move about, in search, as it were, of a new position. The upward displacement is, undoubtedly, the most frequent, but even this is extremely rare. In one of my cases the end of the thigh-bone projected above the acetabulum, where it had formed for itself a superficial socket in the iliac bone, admitting of very slight motion. The true cause, then, of shortening, in the third stage of the disease is not dislocation, but destruction, partial or complete, of the head and neck of the thigh-bone, along with a certain degree of elevation of the corresponding hip.

The changes produced in the affected limb by upward displacement are strikingly illustrated in fig. 610, from a clinical case. The foot is inverted and elevated, the ball resting

Fig. 610.

upon the opposite instep; the knee is bent, and in advance of its fellow; the thigh is firmly flexed on the pelvis, rotated inwards, and adducted, its axis forming an acute angle with the transverse axis of the pelvis; the limb is shortened to the extent of two inches and a half, the amount of true shortening, however, amounting, by actual measurement, to only one inch; the buttock is more full than normal, and pointedly prominent at its external and upper portions; the gluteo-femoral fold is drawn upwards, and the internatal crease is inclined towards the sound side; while the summit of the great tro-

Fig. 611.

Upward Displacement in the advanced Stage of Coxalgia.
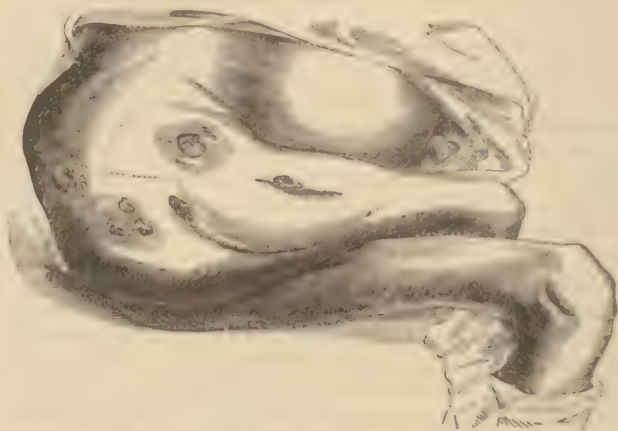
Extensive Malposition of the Limbs in the advanced Stage of Coxalgia.

chanter lies above its natural level. Fig. 611, from Druitt, exhibits, in a striking degree, the extraordinary attitude which the limbs may assume in the advanced stages of coxalgia. The dotted lines indicate the course of the incisions made in the removal of the head of the diseased bone.

The state of the general health, in this stage of the disease, is in strict accordance with the local ravages. The pallid countenance, the wasted muscles, the impaired appetite, the loss of strength and sleep, and the copious night sweats, too clearly indicate the exhausted condition of the system, and the gradual approaches of death. Serious complications, as colliquative diarrhœa, dropsical effusions, and pulmonary phthisis, often arise during the progress of the case, and thus greatly aggravate the suffering. Excessive anemia is nearly always present. Serious disease of the liver occasionally exists, the organ being enlarged, congested, and in a state of fatty or amyloid degeneration. The kidneys are also sometimes extensively involved, but, on the whole, less frequently than might be supposed. They are most liable to suffer when the system is pervaded by the tubercular dyscrasia.

Diagnosis.—Although the symptoms of this disease are usually well marked, especially if some time has elapsed, it is extremely liable to be diagnosticated erroneously.

The inexperienced practitioner, misled by the seat of the pain, too often contents himself with a most superficial examination, and, taking this as the basis of his therapeutic indications, is very apt to misapply his remedies, addressing them, perhaps, solely to the knee, which is only sympathetically involved, when they ought to be directed exclusively to the hip, the actual seat of the morbid action. Numerous cases, illustrative of the truth of this remark, have fallen under my observation, and there are few surgeons in extensive practice who have not, like myself, had occasion to lament the great mischief that has thus been entailed. In a malady so grave as this an error of diagnosis may be fraught with the worst consequences both to the part and system, eventuating, as it necessarily must, in the loss of precious time ; for it but too often happens that, when the true nature of the disease is discovered, all our efforts to arrest its progress are unavailing.

The affections with which this disease is most liable to be confounded, or which may, at least for a time, obscure its diagnosis, are sprains and rheumatism of the ilio-femoral articulation, psoas abscess, purulent collections in the vicinity of the hip and in the upper part of the thigh, and inflammation of the periosteum of the great trochanter.

A *sprain*, twist, or contusion of the hip-joint may, if followed by considerable inflammation, give rise to severe pain and stiffness, seriously weakening, if not completely disabling, the part. The patient, in attempting to walk, raises the hip of the affected side and relaxes the corresponding limb, by bending the knee and retracting the heel, very much as in the earlier stages of tuberculosis. The muscles, also, by degrees become flabby and attenuated, and there is a sensible diminution of the temperature of the cutaneous surface. The gluteo-femoral crease is eventually effaced, and even the general health may suffer. The signs of distinction are, the history of the case, the absence of pain in the knee, the greater latitude of motion, the absence, in general, of constitutional disturbance, and, lastly, the fact that the foot, although everted, is usually easily rotated on its axis, whereas in strumous disease of the hip-joint, it is commonly pretty firmly fixed.

Rheumatism of the hip-joint, chronic and subacute, is generally caused by cold, or by sudden suppression of the cutaneous perspiration, and is seated principally in the ligamentous and synovial structures, the cartilaginous and osseous being seldom involved, except in very severe and protracted cases. The pain, which runs down the front of the thigh, is dull, heavy, or aching ; the gait is limping ; the pelvis is higher on the affected side than on the sound, and the limb exhibits, in the main, the same attitude as in lameness from sprains and contusions, with this peculiarity that the foot is always strongly everted, while in the former case it is generally inclined inwards. The patient in the morning complains of stiffness in the hip, which usually diminishes very sensibly after exercise, but is sure to return in the evening if there has been much exertion or fatigue. The muscles of the thigh are attenuated, but more firm than in tuberculosis, while those of the leg often retain their normal bulk ; the gluteo-femoral fold is effaced ; the limb, owing to the obliquity of the pelvis, appears shorter, often from one to two inches, than natural ; the great trochanter is uncommonly distinct ; and a creaking noise is generally heard if the head of the thigh-bone is forcibly moved upon the acetabulum. Now, although these phenomena bear a very close resemblance to those of strumous disease of this articulation, yet the absence of severe suffering at night, and at all times at the knee, the marked relief afforded by gentle exercise, the trifling annoyance from pressure, percussion, and motion, even when rudely performed, and the rarity of rheumatism in children, together with the frequent coexistence of this disease in other parts of the body, will generally be sufficient to prove that the affection is not tubercular.

It is not often that *psoas abscess* is mistaken for coxalgia ; for, although the matter which is formed in its latter stages occasionally points at the outside of the groin, or at the upper and inner part of the thigh, there is always the most marked difference in the character of the two swellings, independently of other symptoms. In psoas abscess the tumor is usually, at least in its earlier stages, situated above Poupart's ligament, while in hip-joint disease it is commonly below ; in the former it always sensibly diminishes and sometimes even entirely disappears under pressure and recumbency, but quickly reappears when the pressure is removed, or when the patient raises himself up ; in the latter, on the contrary, it never changes its position, or, if it do, it is in consequence solely of the force of ulceration, absorption, and gravitation ; in psoas abscess the swelling receives a distinct impulse on coughing, laughing, and crying, which is not the case in tuberculosis of the hip-joint.

Again, in psoas abscess the principal pain is in the loins ; it is fixed there, and is

always greatly increased by the erect posture, as well as by every attempt to extend the corresponding limb. In coxalgia the pain is most severe in the knee, or in the knee and hip. In psoas abscess there is at no period any change in the position of the great trochanter, nor any alteration in the length of the limb; in hip-joint disease, on the contrary, especially in its more advanced stages, these are prominent symptoms. Finally, psoas abscess occurs nearly always after puberty, whereas the other affection is most common in early childhood.

Sometimes large deposits of *pus* take place in the connective tissue of the nates, or beneath the gluteal muscles, and, forming a prominent tumor in the direction of the ilio-femoral articulation, may thus simulate abscess of the joint from tuberculosis. These accumulations are commonly the result of external injury, or of a phlegmonous, rheumatic, or erysipelatous state of the system, and are, therefore, in general, easily distinguished by their history, by the rapidity of their progress, by the severity of the local distress, and by the comparatively prompt recovery of the parts after the evacuation of their contents. Cold abscesses of the nates, besides being exceedingly infrequent, exhibit none of the diagnostic signs of articular disease, especially such as pain in the knee, or pain in the hip-joint upon rotating the thigh, so characteristic of the latter malady. It is only when they depend upon caries of the innominate bone that the distinction would be likely to be attended with difficulty, and in this case a thorough exploration with the probe would probably furnish the requisite light.

Finally, diagnostic embarrassment, to an annoying extent, occasionally arises from *periostitis* of the great trochanter, especially in persons of a rheumatic or gouty habit of body. The fibrous membrane of this portion of the femur becomes exquisitely painful and tender to the touch, under the slightest motion and percussion, and the disease, extending above the neck of the bone and the capsular ligament of the joint, causes distress and difficulty in walking, with elevation of the corresponding side of the pelvis, similar to what is seen in coxalgia. The soft parts around are swollen and puffy, giving the hip an increased breadth and thickness; by and by suppuration takes place, sinuses form, and small portions of the bone separate and come away. Unless the case is well managed, the joint is rendered stiff, and the patient does not regain his health for a long time. The signs of distinction are, the persistence of the gluteo-femoral crease, the coexistence of rheumatism or gout in other regions, and the fact that the disease usually occurs later in life than coxalgia.

Effects similar to those of rheumatism of the great trochanter sometimes arise from inflammation of the *synovial bursæ* in this situation. The affection is characterized by pain, tenderness, and swelling, by flexion of the thigh upon the pelvis, by difficulty in progression, and by other symptoms simulative of coxalgia. The disease, which occasionally terminates in extensive suppuration, is most common in young, strumous subjects, and is often directly due to external injury, as a blow or fall, causing severe contusion of the parts. The diagnosis rests mainly upon the history of the case, and in thorough exploration of the joint and neighboring structures.

But it is chiefly in the very early stages of this affection that erroneous views of its diagnosis are liable to be formed; when it is fully established, the phenomena are generally too well marked to be mistaken. It has been seen that the very first symptom, in every case, is pain in the knee; so uniform and constant, indeed, is this occurrence, that it must be regarded as pathognomonic, and yet, as was previously stated, it rarely happens that it is referred to its true source. Instead of being considered as an expression of disease of the hip-joint, it is too often regarded merely as an effect of neuralgia, rheumatism, or injury of the knee, to which, accordingly, the treatment is exclusively directed. Its great value, as a diagnostic, is totally overlooked, and thus the disease is allowed to progress at the only time almost when it admits of prompt and radical cure.

In order to avoid this serious and too common mistake, a most thorough examination should be made in every case presenting the slightest suspicion of the existence of tuberculosis of the hip-joint. The very fact that there is pain in the knee, severe in degree, and of frequent recurrence, should of itself excite the alarm of the surgeon, more especially if, added to this, there is a limp in the gait, an increase of suffering after slight exercise, and disturbed sleep at night. If the diagnosis is obscure, the examination must be repeated, again and again, until it is perfectly cleared up. To conduct the investigation properly, the patient must be completely stripped, and viewed both behind and in front, as he stands on the floor. If there is any flattening of the nates, unusual prominence of the trochanter, or change in the gluteo-femoral fold, it will be sure to be detected, and so, also, if there is any alteration in the attitude, size, or length of the corresponding

limb. If the patient be now requested to walk, the amount of limping will be discovered, as well as the manner in which he raises and moves the leg and foot. To complete the investigation, the patient is stretched out on the floor, or on a hard lounge, with a view of ascertaining the amount of suffering produced by rotating the head of the thigh-bone upon the acetabulum, and also by bringing these parts forcibly into contact with each other by percussing the knee, the leg being flexed, or the sole of the foot opposite the ankle, the foot being bent on the leg. The patient being next turned upon his abdomen, the hip is thoroughly examined, first, with reference to the condition of its soft parts, and, secondly, as to the amount of sensibility of the component structures of the joint; finally, if there is any obliquity of the pelvis, it may easily be observed both in the erect and in the recumbent posture; while any change in the length of the affected limb may be determined by extending a piece of tape, or other suitable band, from the anterior superior spine of the ilium to the inner side of the lower extremity of the patella, or from the former point to the sole of the foot, placed at a right angle with the leg. The difference in the length of the measure on the two sides will give the difference in the length of the affected and sound limbs. Actual shortening may generally be easily detected by laying the patient upon his back, and raising the knees at a right angle with the pelvis, where it will be seen that the one on the side affected does not project as far up as the one on the sound side. The attitude of the limb generally affords important information. Early in the disease it is usually slightly abducted, and rotated outwards, whereas in the more confirmed stages, especially when the head and neck of the femur have been partially or completely destroyed, it is always strongly adducted, as well as materially shortened, very much as in a traumatic iliac luxation. There will also, in such a case, be unusual prominence of the great trochanter, and great elevation of the heel. The situation of the sinuses which form during the progress of coxalgia deserves careful consideration in regard to the seat of the osseous disease, or the particular bone involved in the morbid action. Thus in a general way, it may be inferred that, when the track lies at the upper and outer part of the thigh, in the direction of the tensor muscle, the upper extremity of the femur is the bone affected; when the sinus opens upon the gluteal region it implies the existence of disease in the iliac bone, or in this bone and in the femur; a sinus above Poupart's ligament is usually denotive of disease of the ramus of the pubes, and one in the perineum of disease of the ischium. To these rules, of course, occasional exceptions occur. In the examinations of these sinuses a vertebrated or articulated probe will be of great service, as it can be made to follow their sinuosities much more readily than a straight instrument.

Valuable information as it respects the extent of the ravages produced in hip-joint disease may occasionally be obtained by digital explorations of the rectum, or the rectum and vagina. Such examinations are particularly demanded when the existence of pelvic abscess is suspected, or when there is serious disorganization of the iliac bone and its periosteum, or great involvement of the pelvic lymphatic glands. The use of chloroform will often be of great service in conducting the movements of the limb while the patient is recumbent, especially when the parts are very painful and intolerant of manipulation.

Morbid Anatomy.—The anatomical changes which occur in coxalgia are essentially similar to those witnessed in strumous affections of the joints generally. They are usually more conspicuous, in every stage of the malady, in the head and neck of the femur than in the innominate bone, which, however, often suffers very severely during the progress of the morbid action.

When the disease has attained its acme, the synovial membrane, the round ligament, the articular cartilages, and the head and neck of the thigh-bone, with the margins, and frequently, also, the bottom of the acetabulum, are partially destroyed, if not completely annihilated. In the more severe cases the cotyloid, transverse, and even the capsular ligament are entirely absorbed, the surrounding parts are extensively separated by the ulcerative and suppurative processes, numerous fistulous openings exist, and the gluteal muscles are transformed into dense, firm bodies, of a pale-reddish, yellowish, or whitish color. Sometimes, especially when the disease is of long standing, these muscles undergo the fatty degeneration. Occasionally both trochanters are absorbed; or there is extensive caries of the innominate bone; or the head and neck of the thigh-bone are necrosed; or the joint contains numerous fragments of bone and cartilage; or, the bottom of the acetabulum being perforated, the matter extends into the pelvis, and passes off by the rectum. In children, prior to the completion of the ossific process, the hip-bone is sometimes separated, at the acetabulum, into its three primitive pieces; and epiphyseal sequesters of the head and neck of the femur are also occasional occurrences.

When the head and neck of the femur are absorbed, the remnant of its superior ex-

tremity usually lies across the acetabulum, or in its immediate vicinity. Occasionally it is drawn up a little beyond this cavity, against the surface of the ilium, resting in a slight depression, which, however, bears only a very faint resemblance to a new socket. Instances have been observed in which it was forced backwards into the sciatic notch, forwards upon the pubic bone, or downwards into the thyroid foramen. When the disease has expended itself mainly upon the acetabulum, the head of the thigh-bone may retain its original position, or it may even be pushed into the pelvic cavity. The ravages produced by this disease, in its earlier stages, in the acetabulum and the head and neck of the femur, are well illustrated in the annexed cut, fig. 612.

Fig. 612.

Changes wrought in the Acetabulum and Head of the Thigh-bone in Coxalgia.

An examination of the bodies of those who die from the effects of coxalgia always reveals important lesions of some of the internal organs. In 1858, I published an elaborate paper upon tuberculosis of the hip-joint, accompanied by an account of the post-mortem appearance of five cases, the ages of which were, respectively, nine, ten, twelve, twenty-three, and twenty-six years, in every one of which there were numerous tubercles in the lungs, either in a crude, softened, or ulcerated condition. The spleen, in three of the cases, was crowded with tubercles, and in nearly all tubercles were present in the pelvic and mesenteric glands. The liver was similarly affected in one of the cases, the kidneys in two, and the bronchial lymphatic glands in one. The peritoneum, in one of the cases, was studded with tubercles, and its cavity contained three quarts of serous fluid. These cases, so far as they go, clearly prove the connection of coxalgia with a strumous state of the system, either as cause or effect. Amyloid degeneration of the kidneys is not infrequent in the more advanced stages of the disease, and, together with tubercular meningitis, is a considerable source of its mortality. Many children perish from mere exhaustion, worn out by profuse suppuration, loss of appetite, night sweats, and hectic irritation.

No one who has studied the pathology of this disease can doubt its tubercular character. The researches of Billroth, Koenig, Bidder, Volkmann, and other German investigators clearly point to this conclusion; and similar evidence is afforded by the elaborate statistics of Dr. Gibney, showing as they do a large percentage of hereditary influences. Many American, English, and French surgeons are converts to this doctrine, and it may safely be predicted that the time is rapidly approaching when this belief will become general, if not universal. The fact that external injury often acts as an exciting cause of the disease does in no wise invalidate the truth of this opinion. Traumatism, in any case, is simply an exciting cause, and nothing more: wholly inoperative when there is no local or constitutional vice or predisposition. "It is impossible for a physician," says Gibney, "to be long connected with a dispensary or hospital in a large city without coming to the conclusion that some vice, either hereditary or acquired, must underlie the constitutions of the vast majority of the poor who lack medical assistance." For some recent views upon this subject, the reader may with advantage consult a paper by Mr. John Croft, of St. Thomas's Hospital, in the Transactions of the Pathological Society of London for 1881.

Prognosis.—As there are no mortuary statistics of this affection, it is impossible to state, with any degree of precision, the mean duration of fatal cases, or the relative proportion of deaths to recoveries. My opinion, founded upon numerous observations, is that the mortality from coxalgia is slight in almost any event, even when there has been palpable neglect in regard to its treatment. The prognosis is generally most unfavorable in feeble, anemic children, with a tumid upper lip and a protuberant abdomen, the offspring of strumous parents, or of persons whose system is thoroughly impregnated with the syphilitic poison. Young adults seldom ever recover, if suppuration occur; the whole system soon becomes involved in the disease, and they rapidly sink under the profuse discharge and hectic irritation. Few children die before the eighteenth month. The case is always more likely to terminate unfavorably when the disease involves the acetabulum, or the acetabulum and the surrounding osseous tissue, than when it is limited to the head and neck of the femur. Primary disease of the acetabulum is also a much more serious

occurrence than secondary disease, or disease consequent upon disease of the thigh-bone. Under the present improved mode of treatment, more lives are saved than formerly, as well as more useful limbs retained. If the disease has been neglected, and recovery occurs, the individual will be permanently deformed and crippled, and a long time will elapse before he will be able to regain his health. The hip is often completely ankylosed without the previous formation of an abscess.

The angle which the limb forms with the body in cases of recovery, varies, according to Gibney, from 90°, as the minimum, to 150°, 160°, or even 170°, as the maximum. The shortening is generally very slight when there is no serious structural change in the articular surfaces; when the reverse is the case, and especially when there is great destruction of the head and neck of the thigh-bone, the shortening may amount to two, two and a half, three, and even four inches. The disease sometimes lasts for many years, and yet the patient may finally recover, enjoying, perhaps, tolerably fair health during the remainder of his life.

Treatment.—Although the treatment of coxalgia involves the same principles as that of tuberculosis of the joints in general, there are certain points to which it is necessary to direct special attention, growing out of the peculiar structure and situation of the articulation, the frequency with which it is assailed by this disease, and the tender age of those who are most obnoxious to its attacks.

Rest of the affected joint, as well as of the whole body, is of primary importance, and should be attended to without delay. The restraint must not be limited to a few days or weeks, but be continued so long as there is the slightest evidence of active disease. In order to render the patient as comfortable as possible, and enable him to endure his protracted confinement without detriment or inconvenience, a suitable bed provided with slats and a firm but elastic mattress must be secured. A common trundle-bed, about four feet in width, will answer every purpose, and is, in every respect, preferable to the common bed, especially if the patient be a child, as he will thus be less liable, if he should roll out, to hurt himself. The sheet should be well fastened at the sides, that it may not become rumpled, and the pillow should be very thin, so that, while it affords adequate support to the head and shoulders, no undue weight may be thrown upon the trunk and pelvis. The confinement, however rigid, will not prove irksome; with the aid of toys and other sources of amusement the little patient will generally in a few days become reconciled to this new mode of life.

With strict attention to this point, the disease, if in its incipiency, may generally be easily arrested without any formal treatment, excepting, perhaps, the occasional exhibition of a laxative and a proper regulation of the diet. If the joint is stiff, and painful on pressure, a few leeches may be applied, or the skin may be thoroughly painted once a day with dilute tincture of iodine, or a small blister may be raised, and the raw surface sprinkled with morphia. A diaphoretic and anodyne draught may, if fever exist, be administered at bedtime. The best laxative, in this stage of the disease, is calomel, in doses of one to two grains with twice that quantity of jalap. The diet must be very plain and simple, especially if the patient be, in other respects, well conditioned. General bleeding will seldom be required, unless the suffering is extremely severe and the blood decidedly thick and abundant, when the loss of a few ounces cannot fail to be highly beneficial.

To control the spasmodic action of the muscles, and thus afford more perfect repose to the diseased joint, the limb should be confined by a splint, extending from near the crest of the ilium to within a short distance of the ankle, and so constructed as to cover in nearly the whole of the affected buttock. The most suitable materials are wire gauze, gutta-percha, undressed sole-leather, or trunk-maker's board, soaked in hot water, carefully moulded to the hip, thigh, and leg, and kept in place with adhesive plaster and a common roller. When dry, these substances form an admirable case, which, if properly padded, effectually wards off pressure and prevents excoriation. To render any contrivance of this kind thoroughly efficient by placing the affected joint in a state of perfect repose, beyond the spasmodic action of the muscles of the thigh, extension and counter-extension must for some time be steadily maintained in the same manner as in the treatment of fractures of the lower extremity, that is by adhesive plaster, pulley and weight, and by elevation of the foot of the bed. The weight should vary according to the age of the patient, from two to four, six, or eight pounds, its effect being carefully watched, otherwise it may give rise to great discomfort, if not serious detriment. Dr. Physick, who was the first to insist upon the necessity of absolute rest in the treatment of coxalgia, used a splint of carved

Fig. 613.
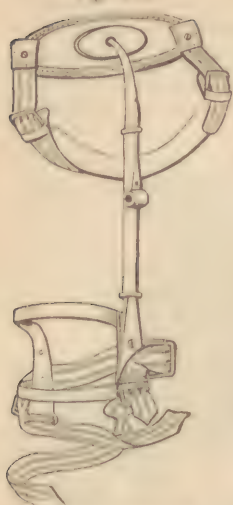
Sayre's Apparatus.

wood, very light, well padded, and carefully adapted to the size and shape of the hip and limb. When the patient is in a condition to exercise in the open air, there is no apparatus that answers so good a purpose for securing quietude to the affected joint as that of Dr. Sayre, or one that can be used with greater ease and comfort. It consists, as seen in fig. 613, of two pieces of corrugated steel, the lower of which is made to slide within the upper by means of a key, thereby forming a splint which extends from the crest of the ilium to two inches above the condyles of the femur. To the upper end of the splint is attached, by means of a ball and socket joint, a padded, concave steel plate, which rests upon the pelvis just below the crest of the ilium, and to each extremity of which the perineal band, made of buckskin, stuffed with hair, and terminating in elastic webbing, is secured by buckles. At the lower end of the splint are a roller and buckle intended to receive a webbing stitched to the retaining adhesive plaster, while two semicircular steel bands pass from this portion across the front of the thigh to another straight piece which rests on the inner side of the limb, parallel with the outer bar, and also terminates in a roller and buckle. A strap which extends posteriorly from the inner to the outer rod, is intended to secure this portion of the apparatus when it is adjusted.

To apply the instrument, two fan-shaped pieces of strong, inelastic adhesive plaster, with webbing sewed on to their narrow ends, are required, long enough to reach from the perineum to within two inches of the inner condyle and from the great trochanter to a similar point on the outer side of the limb. These having been secured by a roller, the splint is laid over the thigh, and the webbing, attached to the plaster, fastened over the rollers to the buckles on its lower end, the traction being completed by securing the posterior strap. The perineal band is then buckled on, and extension is made with the key, to such a degree as to render the patient comfortable. With the assistance of a crutch, he may, with this contrivance, exercise during the day in the open air, while at night, as he lies in bed, the requisite degree of extension may readily be effected by means of a pulley, cord, and weight, attached to the limb in the usual manner. In connection with exercise in the open air, I may mention, with special emphasis the ingenious method of treatment recommended by Dr. Joseph C. Hutchison, of Brooklyn, and now much employed in this, if not also in other countries.

Fig. 614.

It simply consists in removing the weight of the body from the affected limb to the sound one by means of an elevated shoe and a pair of crutches as seen in figs. 615 and 616. By this very simple arrangement the affected limb is suspended during progression and maintained in an easy and relaxed position. At night extension may be applied or not, according to the absence or presence of muscular spasm. Dr. Hutchison's shoe is the one ordinarily used for shortened legs provided with a steel plate corresponding to the sole, to which it is attached by two upright rods from two and a half to three inches in length, so as to raise the foot from the ground. In order to avoid vicious position and keep the joint thoroughly at rest, this treatment should be supplemented by the application of the posterior splint of Thomas, represented in fig. 617. The only objection to this contrivance is that it renders sitting very awkward, to obviate which Dr. Willard has devised the admirable apparatus, depicted in fig. 618, which is particularly adapted to the earlier stages and milder forms of the disease, where gentle motion is permissible, and ankylosis is to be prevented. It is made of perforated leather, and consists of two pieces, one corresponding with the thigh, and the other with the hip and pelvis, connected by a hinge-like joint, which may be hooked or unhooked at pleasure. It is accurately moulded to the surface, and is laced down in front of the thigh and abdomen.

In the *second stage* of the affection, the great topical remedy is an issue made with the actual cautery, applied to the most prominent part of the swelling, or as nearly as possible to the focus of the morbid action. The eschar, which should be from half an inch to an inch in diameter, usually drops off in six to eight days; the sore, besides furnishing an ample supply of thick pus, affords an excellent surface for the endermic use of morphia,

now so necessary for allaying the violent pains and spasmodic twitchings of the muscles. If the discharge flag, it can easily be reëxcited with some stimulating unguent. It should

Fig. 615.

Fig. 616.

Fig. 617.

Hutchison's Shoe.

Hutchison's Shoe Applied.

Thomas's Posterior Splint.

be maintained in full force until the severity of the disease has completely subsided. The quantity of morphia necessary to compose the parts and system is, according to the age and other circumstances of the patient, from a quarter to a third of a grain sprinkled upon the surface of the issue once or twice a day. If the general health suffer from want of exercise, the limb may be put up in a suitable apparatus, and the child sent into the open air.

The violent contraction of the muscles, so common in this stage of the complaint, and a source of so much pain and distortion, may generally be promptly relieved by the use of the tenotome. The muscles that are most frequently at fault are, the sartorius, pectineal, and short adductor, which, if they do not yield under the influence of chloroform, should be thoroughly divided near their origin, until all resistance to the extension of the limb is overcome.

In the *third stage* of the disease, when abscesses exist in and around the joint, accompanied by hectic irritation, the indications plainly are to evacuate the matter and to support the system. The knife should be introduced in such a manner as to make a valvular incision, as in an ordinary strumous collection, the opening being immediately closed with adhesive plaster, and the operation repeated at intervals of six, eight, or ten days, until all tendency to reaccumulation has disappeared. The object should be, while affording free discharge to the pent-up fluid, to permit as little air to penetrate the joint as possible. Undue reaction must be prevented by full and sustained doses of opium until the part and system have accommodated themselves to their new relations. Quinine and iron, cod-liver oil, beef essence, milk punch, and elixir of vitriol will afford material aid in maintaining the

Fig. 618.

Willard's Splint.

strength at this trying juncture. Any dead bone that may exist must for obvious reasons at once be removed. When the pus has been evacuated, the affected parts should be supported with some sorbefacient and slightly stimulating plaster, as the soap, galbanum, or ammoniac and mercurial, the latter being the best. The sinuses about the joint may be injected with a weak solution of iodine, iodide of iron, nitrate of silver, bichloride of mercury, permanganate of potassium, or chlorinated sodium. If numerous, and not too deep, they may often be advantageously laid open, provided it can be done without pain and the loss of blood. As soon as the patient is able, he should exercise in the open air; and the affected joint should be moved to prevent ankylosis.

When the parts in and around the joint are so much diseased as to render recovery by the ordinary means entirely hopeless, the only thing that remains to be done is excision. The operation, the statistics of which will be given in a future chapter, may be conveniently performed by making a curvilinear incision, from four to five inches in length, perpendicularly over the joint, in a line with the great trochanter, separating the parts, and cutting off the diseased structures with the saw or pliers. If more room be required, the incision may be crucial, or in the form of a T or V. The flaps are afterwards approximated with stitches and adhesive strips, and the immobility of the limb is secured by appropriate splints, pads, and bandages, as in fracture of the thigh-bone.

Important information on the comparative value of the expectant plan of treatment and excision in disease of the hip-joint has recently been published by a committee of the Clinical Society of London. Of 384 cases treated by prolonged rest, extension by weights, and opening abscesses, 100, or 26 per cent., died, 87 of the deaths having occurred in 260 of the cases in which suppuration was present: 196 of the patients were reported as cured or as convalescing, while in 88 the disease was still in progress. Of the 260 cases in which suppuration had taken place, 33.5 per cent. died, while of 45 cases of excision performed by Mr. Croft, 40 per cent. were fatal. In favor of excision, however, it may be said that the movements of the limb are more frequently retained, as well as more extensive, than when the expectant plan is pursued; on the other hand, however, the limb is less firm and less useful for the purpose of progression.

When, as occasionally happens, a sequester exists in the neck of the femur, whether as the result of actual necrosis, or of epiphyseal disjunction, excision should give way to the ordinary operation for the removal of dead bone. Such an occurrence is by no means infrequent, and the surgeon should, therefore, spare no pains to ascertain the true condition of the parts before he adopts so severe a measure as excision.

When the acetabulum is involved in the disease, it should be dealt with in the same manner as the femur, every particle of morbid structure being removed with the pliers, gouge, chisel, and scraper. With proper care, there will be no danger whatever of injuring any of the contents of the pelvis, inasmuch as the periosteum and connective tissue are always so greatly indurated and thickened during the progress of the disease as to serve as a strong wall of defence. When, as is sometimes the case, after such an operation, the blood oozes from numerous points, a prompt and effectual stop may usually be put to the flow by means of hot water or of Monsel's salt, applied upon wet cotton.

When the patient has been exhausted by protracted suffering, and life is fast ebbing away, it has been proposed, as a dernier resort, to amputate at the hip-joint; and the records of surgery contain several examples in which the operation was performed successfully. I should, nevertheless, hesitate before undertaking so grave a procedure, the more especially as the same end may generally be more readily attained by the more simple and less dangerous operation of excision. It is only, indeed in cases of great disorganization, deformity, or wasting of the limb, rendering it utterly useless as an organ of progression, or interfering more or less seriously with the ordinary movements of the body that, in my opinion, amputation should be preferred to excision of the head, or head and neck of the femur.

The deformity of the limb and pelvis, consequent upon the disease, may often be very materially relieved, if not completely removed, after the morbid action has measurably subsided, by careful extension and counterextension of the limb, by means of a weight and pulley, conjoined with passive motion, and the use of suitable apparatus when the patient begins to exercise in the open air. One of the best contrivances for this purpose is that depicted in the adjoining cut, fig. 619, one of the many ingenious inventions of the late Professor Pancoast. In fig. 620, the apparatus, which should always be as light as is consistent with strength and durability, is exhibited as applied to the patient. It is of course laid aside at night, and before it is readjusted in the morning, the limb should

always be well washed and rubbed. It is hardly necessary to add that the exercise should be as gentle as possible, that it should be taken with the aid of a crutch, and that it should never be carried to fatigue. The disease which too often slumbers may be easily reawakened, if these precautions be not rigidly enforced.

Fig. 619.

Fig. 620.

Pancoast's Apparatus for Coxalgia.
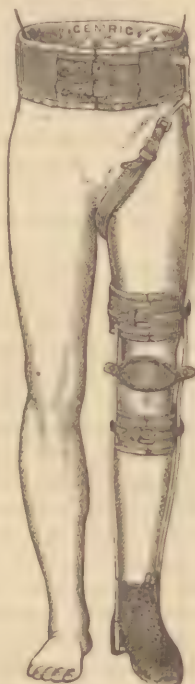
Splint Applied.

The adhesions of the joint and of the surrounding structures are most easily broken up with the aid of an anæsthetic. Unless great attention be bestowed upon the case for a long time after the active disease has vanished, great and irremediable deformity will be inevitable.

Much, if not irreparable, injury is often inflicted upon the part and system by injudicious passive motion in the treatment of coxalgia. It is only, or mainly, in the earlier stages of the disease that such efforts will be at all likely to prove beneficial. When the joint has undergone serious structural changes, as when the disease is well advanced in its second stage, in which there is always more or less destruction of the synovial membrane, if, indeed, not also of the articular cartilages, the only rational thing to be done is to place the corresponding limb in the best position for future usefulness, and to favor the occurrence of ankylosis instead of adopting measures to prevent it. The altered structures in such a condition cannot possibly be reclaimed by any skill, however great or well directed, of the surgeon, and hence any attempts that may be made with a view of reëstablishing motion must inevitably end in failure, if not, in what is much worse, in the rekindling of morbid action. It is, as it were, taking the case out of nature's hands, and thwarting her efforts at a cure by rendering the affected joint permanently motionless. In the propriety of this advice all surgeons of experience will, I am sure, concur.

SECT. VIII.—CHRONIC RHEUMATIC ARTHRITIS.

The joints are liable to a peculiar form of disease, known under the name of chronic articular rheumatism, or chronic rheumatic arthritis, first systematically described by Dr. R. W. Smith and Dr. R. Adams, of Dublin, the latter of whom has published an able and elaborate treatise upon it. It occurs in both sexes, chiefly in elderly and middle-aged subjects among the laboring classes, although it is also occasionally observed in the

higher orders of society, especially in the indolent and habitually intemperate in eating and drinking. The joints most prone to suffer are those of the hip, knee, wrist, and fingers, one of which only may be affected, or a number may be implicated simultaneously, or in more or less rapid succession. Sometimes the disease leaves one articulation, and fastens itself upon another; but, in general, when it has once effected a firm lodgment it holds on to it pertinaciously, now and then remitting, but seldom entirely intermitting, at least not for any length of time. Ill-fed and ill-clothed persons, living in moist, under-ground apartments, or in damp, confined alleys, are particularly liable to it. A gouty or rheumatic predisposition probably favors its outbreak.

The immediate cause of the disease is generally suppression of the cutaneous perspiration from exposure to cold, or from long-continued immersion of the feet in water, as often happens in the laboring classes. Occasionally its origin is traceable to external injury, as a blow, sprain, or concussion. In the female it is sometimes apparently dependent upon irregularity of the menses; and in both sexes it is frequently connected with dis-order of the digestive apparatus, as dyspepsia, constipation, or derangement of the biliary secretion.

The disease often, if not ordinarily, approaches in a slow and stealthy manner, the first symptoms being usually merely a sense of soreness and stiffness of the affected joint, with slight derangement of the general health. As it progresses, the local distress assumes a more marked and open character; what was before only a feeling of uneasiness now becomes a source of real pain and distress. The joint gradually growing rigid, moves with great difficulty, and a careful examination seldom fails to detect fluctuation, dependent upon the presence of synovial fluid, an early product, and generally the principal one, of inflammation in its milder forms. When the effusion is considerable, it will necessarily seriously change the contour of the affected joint, the synovial membrane bagging across the ligaments, as is so apt to happen when the disease is seated in the knee, wrist, or elbow. It is seldom that pus forms in any case, even if unusually severe and protracted; but plastic matter is often poured out in large quantity, and it is the presence of this substance that causes the remarkable rigidity which so constantly attends the com-plaint in its more severe grades. Spasmodic twitchings of the muscles in the neighbor-hood of the affected joint commonly set in at an early period of the inflammation, and constitute a source of great distress, effectually interrupting sleep, and requiring large doses of anodynes for their relief.

The pain in chronic rheumatic arthritis is often excessive; it is always increased by motion and pressure, and is usually materially aggravated at night. It is of a dull, heavy, aching character, and frequently extends in different directions, but especially along the course of the larger nerves, which it sometimes follows to their very extremities. The general health suffers severely; the patient is feverish, and deprived of appetite and sleep; the bowels are constipated; and the skin is hot and arid. The urine, however, although commonly scanty and high-colored, does not deposit any lithic acid, a circum-stance which remarkably distinguishes this disease from gout and rheumatism, properly so called.

In old cases of this disease, or in the strictly chronic form of it, the general health, although perhaps somewhat impaired, is comparatively good, and the patient may even grow fleshy and ruddy. His locomotive powers, however, are greatly deranged, and he is, in consequence, often obliged to use crutches. The affected joints are habitually ten-der, sore, and distorted, not unfrequently presenting an appearance of being partially dislo-cated. Such a change is particularly liable to occur in the fingers, but is also occasionally noticed in the hip, shoulder, and other large articulations. Exostoses sometimes spring from the sides of the affected joints and serve to add to the deformity, already sufficiently great. The synovial burses are also apt to suffer, becoming inflamed, enlarged, and dis-tended with fluid. The muscles, in consequence of their perpetual inactivity, become atrophied and powerless. What strikes the observer as very peculiar, amidst these changes, is the entire absence of cretaceous deposits in and around the disabled joints.

Chronic rheumatic arthritis is essentially an inflammatory malady. The affected struc-tures, if examined in the earlier stages of the disease, will be found to exhibit indubitable evidence of vascular injection of the synovial membrane, and of the presence of synovial fluid, with here and there, perhaps, a patch of lymph, or more or less of this substance intermingled with the other secretion. Pus, as already stated, is seldom seen. When the disease is permitted to go on unchecked, great structural changes gradually take place, consisting in the removal, either partial or entire, of the synovial membrane and articular cartilages, and the conversion of the extremities of the bones into a hard, ivory, or por-

cellaneous substance, totally destitute of its normal qualities. In many cases the ends of the bones have a beautiful polished aspect, being perfectly smooth and glistening; while in others they are remarkably rough and tuberculated, or beset with exostosic incrustations. The interarticular fibro-cartilages are generally completely destroyed, and the funicular ligaments often undergo partial absorption, while the capsular are liable to become stretched and relaxed, thus allowing the bones to slip away from each other, and produce an appearance of partial dislocation. Finally, fibroid, fibro-cartilaginous, and osseous growths, of various shapes and sizes, are extremely prone to form in the interior of joints thus affected.

What is the pathology of this disease? That it is of an inflammatory nature, is unquestionable; but how it is produced, or what the peculiar condition of the system is which predisposes to its development, or which keeps the affection in play after it has been fairly established, are circumstances in its history of which we are totally ignorant.

The diagnosis is commonly very easy, especially in the more chronic forms of the disease. The history of the case, the excessive obstinacy of the disease, and the gradual failure of the functions of the affected joint, together with its distorted appearance, and the absence of cretaceous deposits in the structures around the articulation, and of lithic acid in the urine, always readily distinguish it from ordinary gout and rheumatism, the only maladies with which it is at all liable to be confounded.

The prognosis is generally most unfavorable. In the milder forms of the disease, and in its earlier stages, a cure is certainly occasionally practicable, but under opposite circumstances the patient almost invariably remains a cripple for life, as it is impossible by any mode of treatment at present known to effect restoration of the disorganized structures of the affected joints.

Treatment.—In the treatment of this affection, everything depends upon the efficiency with which the case is met in its earlier stages; for, after the morbid action has made serious inroads, all that can, in general, be expected from remedial interference is a mitigation of suffering, seldom anything like a complete, permanent cure. Unfortunately it but too often happens that the disease has occasioned great disorganization of the affected structures before the practitioner is afforded an opportunity of taking it in hand. Considering its inflammatory character, the course of treatment to be adopted is indisputably the antiphlogistic, directed not to the part merely, but also, and in an especial manner, to the state of the general system, which, whatever may be the real pathology of the disorder, is always more or less extensively implicated. In this country there are few cases of chronic rheumatic arthritis which will not, in their earlier stages, bear active depletion by the lancet, purgatives, diaphoretics, and antimonials. The quantity of blood taken from the arm must, of course, depend strictly upon the condition of the constitution, as to the existence or absence of plethora, anorexia, and other evidence of vascular disturbance. Mercurial purgatives administered in efficient doses, in union with jalap or rhubarb, and compound extract of colocynth, are among the most reliable means that can be employed for arresting the morbid action; and it would be difficult to conceive of any case in which they can altogether be dispensed with. At the same time, however, they must be used with caution. The improvement of the secretions always forms an important indication, and there is no class of remedies so likely to do this promptly and effectually as purgatives. After the violence of the disease has been moderated by these means, the most efficient prescription, according to my observation, is a combination of morphia, antimony, and veratrum viride, given in full and sustained doses, until it makes its specific impression upon the heart and nervous system. Half a grain of morphia, with one-sixth of a grain of tartar emetic, and ten drops of tincture of veratrum viride, is a fair average quantity for an adult, to be repeated once or twice in the twenty-four hours, according to the severity of the suffering, or the effects of the remedy, which should, of course, always be carefully watched. Administered in this way, it promptly subdues pain, produces perspiration, and reduces vascular excitement. When this result has been brought about, the medicines are given in smaller or less frequently repeated doses, until the necessity for their exhibition entirely ceases.

Colchicum is seldom of any material benefit in this disease in any of its stages; for, although the disorder unquestionably generally partakes of a rheumatic or gouty nature, yet, as already stated, there is rarely any lithic acid deposit in the urine, or cretaceous formation within the joints, and this is probably one, if not the principal, reason of the inefficiency of the medicine. Dover's powder may occasionally be employed with great benefit; and salicin is also worthy of trial.

Among the more important topical remedies are leeches and fomentations, medicated

with acetate of lead, opium, and aconite. Local steam baths are sometimes highly beneficial, the vapor being conducted by means of a tube to the inflamed parts. Cold applications are rarely admissible, from their tendency to shock the system and to cause metastasis. As the disease declines, dilute tincture of iodine and steady, systematic compression with the bandage will be found serviceable; and, at a still later period, passive motion may be instituted, the parts around the joint being at the same time well douched and shampooed, to promote the absorption of effused fluids and the restoration of impaired function.

In the more advanced chronic forms of the affections the main reliance of the practitioner must be upon a proper regulation of the diet, which must be chiefly of a mild, farinaceous character, with a little white meat or fish at dinner; the preservation of the secretions by the occasional exhibition of a few grains of blue mass, or calomel; the steady, persistent use of iodide of iron, either alone or in union with iodide of potassium; and a residence in a dry, genial climate, exempt from sudden and severe vicissitudes. A sojourn for several months at the Hot Springs of Arkansas, with the daily use of the warm baths obtainable at that place, often proves serviceable. If the general health is much broken, cod-liver oil with iron and quinine may be required, the body being incased in flannel, and gentle exercise taken in the open air, to prevent ankylosis, which is always so much favored by inactivity in all articular affections, of whatever character.

When the disease is followed by permanent ankylosis, an attempt may be made to place the corresponding limb in proper position by separating the ends of the bones by means of the perforator and chisel, as advised in the section on ankylosis; or, if the case do not admit of such interference, excision might be practised, as was done, although unsuccessfully, in an instance of this kind, by Ridewald, in 1770. His patient, a man of fifty years old, was in bad health at the time, and died from the conjoint effects of suppuration and hemorrhage after amputation, performed as a dernier resort. I am not aware that an operation for such an object has been employed by any other surgeon, and yet it is easy to perceive that cases might arise rendering a resort to the knife highly proper.

CHRONIC RHEUMATIC ARTHRITIS OF PARTICULAR JOINTS.

Although this disease may, as already stated, occur in any of the joints, it is by far most frequent in those of the carpus and fingers, where it is always readily recognized by the pain, stiffness, and permanent distortion which it occasions. The elbow, wrist, and ankle-joints rarely suffer from it. When the malady is constitutional, the sterno-clavicular and acromio-clavicular articulations are liable to be invaded, and it then often requires more than ordinary care and skill to determine the diagnosis, especially if the parts have recently been subjected to local injury, as a blow or fall, thus exciting doubt as to whether the affection is one of rheumatism, dislocation, or fracture. In a practical point of view, however, it is chiefly in the lower jaw, spine, elbow, hip, and knee that the disease is of much interest.

Chronic Rheumatic Arthritis of the Lower Jaw.—In the lower jaw the disease is frequently symmetrical, although it rarely exists in an equal degree on both sides. The subjects are usually elderly men, after the fiftieth year, who have been exposed to all kinds of hardships. Among the earlier symptoms is a slight degree of stiffness in the joint, which is soon succeeded by pain, and by a creaking, crackling, or grating sensation, particularly annoying during eating, and often so loud as to be heard at some distance. The cause of this sensation is evidently an absence of synovial fluid. The condyloid process increases in size, and forms a distinct knob in front of the ear. The mouth is opened with difficulty, mastication is greatly restricted, and the chin and face are distorted from the destruction of the articular eminences, allowing the external pterygoid muscles to drag the bone out of its natural position. When both joints are affected the chin is elongated, but if only one suffers the jaw is thrown towards the opposite side, very much as in a traumatic unilocular dislocation. The pain is generally worse at night than in the day, as well as in damp than in dry weather, and there is often considerable enlargement of the lymphatic glands of the upper part of the neck. The fibro-cartilage is destroyed; the surfaces of the joint, divested of their natural coverings, are of a porcellaneous hardness; the articular eminences are flattened, if not entirely wasted; and the condyles are enlarged and disfigured.

The diagnosis is determined principally by the age of the patient, the gradual changes in the joint, face, and chin, and the symmetrical character of the attack.

Chronic Rheumatic Arthritis of the Spine.—This disease occasionally invades the spine, especially the cervical and dorsal divisions ; the subjects are generally elderly persons, and the attack is commonly associated with the same affection in other regions of the body. The most distressing forms of the disease are met with in the lower part of the neck and the upper part of the back, where it often causes great deformity, the curvature being a combination of the posterior and lateral varieties. The trunk, in time, becomes greatly arched, and the patient is unable to stand erect, or to turn his head from side to side. The earlier symptoms are, gradually increasing pain and stiffness, and a crackling noise heard on motion of the affected joints.

The diagnosis rests upon the history of the case, as the age of the patient, the absence of local tenderness, or, what is tantamount to this, the tolerance of the parts under rough manipulation, and the fact that the patient does not experience any marked pain if the spine be forcibly concussed through the skull as he sits upon his chair.

Chronic Rheumatic Arthritis of the Shoulder.—When this disease attacks the shoulder, it may come on either as an independent affection, as when it is caused by external violence, or, as is more generally the case, it coexists with chronic arthritis of some of the other articulations. The earlier symptoms are, stiffness of the joint, with a crackling sensation on moving the arm, a deficiency of synovial fluid, more or less pain, especially at night, and in damp states of the atmosphere, and gradual wasting of the deltoid muscle. As the disease proceeds, the joint becomes more and more rigid, from the dryness of its surfaces, and the effects of plastic deposits, the shoulder presents a wasted appearance, the acromion and coracoid processes stand out in bold relief, and the movements of the arm are restricted within the most narrow limits. The patient can still abduct the limb slightly, but he finds it impossible to elevate it to a horizontal level, or to carry it behind the trunk. The head of the humerus is generally a little raised, as well as somewhat nearer the middle line than natural, the scapula is unusually mobile, and a remarkable depression exists at the posterior part of the joint.

The diagnosis is established by the history of the case. When the disease is constitutional, its coexistence with similar attacks in other joints is sufficiently denotive of its character. When it is caused by injury, it may be confounded with tuberculosis, from which, however, it may readily be distinguished by the crackling sound that attends the movements of the arm, and by the fact that the parts are much more tolerant of pressure and rude manipulation. In caries of the joint the slightest motion is productive of intense pain, there is more swelling, with greater constitutional disturbance, and the affected structures ultimately run into suppuration, an effect which is never witnessed in chronic rheumatic arthritis.

When a person, affected with this disease, is so unfortunate as to meet with a fall or blow upon the shoulder, the surgeon may find it very difficult, if not impossible, unless he is fully acquainted with the previous history of the case, to determine whether the affection is one merely of sprain, fracture, or dislocation.

The head of the humerus, partly absorbed, flattened, and nodulated, is denuded of cartilage at one place, porous at another, and eburnized at a third. In very old cases it generally rests against the under surface of the acromion and coracoid processes, in a kind of socket formed for its accommodation. These processes themselves are often greatly changed ; sometimes they are much enlarged and roughened, at other times completely wasted. The glenoid cavity is expanded and excavated, while its margin is elevated into a sharp, irregular ridge. Sometimes all these parts are soldered together by osseous matter.

The soft structures around the joint are materially altered, the muscles are pale, wasted, and flabby, the long head of the biceps is destroyed, the tendons have a macerated appearance, as if their fibres were separated into their original elements, and the capsular ligament is thickened and perforated, or hypertrophied at one point and atrophied at another.

Chronic Rheumatic Arthritis of the Hip.—This affection is nearly always met with in elderly persons laboring under the rheumatic diathesis. For this reason it frequently coexists with the same disease in other parts of the body. Sometimes, however, it is limited to one of the hip-joints, and is then generally caused either by external violence, or by suppression of the cutaneous perspiration. Falls and blows upon the great trochanter occasionally give rise to it. Males are by far its most frequent subjects.

The earliest evidence of the disease is a stiffness in the joint, which is generally most annoying in the morning when the patient gets out of bed, but which gradually diminishes after exercise, provided this is not carried to severe fatigue, which always produces an opposite effect. At first there is little or no pain, but after a while this becomes a prominent and distressing symptom. It is either dull and aching or of a gnawing or boring

character, and is most severe in the joint and in the great trochanter, from which, however, it radiates in different directions, as up into the gluteal region and down along the thigh, often as far as the knee and even the leg. It is increased by motion and exercise, is worse at night than in the daytime, and is influenced by the state of the atmosphere. The patient walks very lame, and, as he supports the weight of his body upon the sound limb, the affected one is drawn up in such a manner as to give it a shortened appearance. The foot is strongly everted, the power of rotation is lost, the buttock is flattened, the gluteo-femoral crease is effaced, the muscles of the thigh are attenuated, and a crackling sensation is perceived on moving the joint. The patient cannot stoop when he stands, and when he sits he is compelled to stretch out his leg. The trochanter is unusually prominent, and progression is painful and restricted. Great shortening of the limb at length takes place, often amounting, apparently, to two and a half or even to three inches, but, in reality, seldom exceeding one-third of that amount, and depending mainly upon the wasted condition of the head and neck of the thigh-bone.

The principal affections with which this disease is liable to be confounded are tuberculosis and sciatica. From the former it may usually be readily distinguished by the fact that the malady nearly always occurs in elderly subjects, by its frequent coexistence with similar attacks in other parts of the body, by the peculiar crackling sensation produced on moving the joint, by the absence of heat, swelling, and tendency to suppuration, by the greater tolerance of the parts under rude manipulation, by the flattening of the nates, by the remarkable prominence of the trochanter, and by the natural appearance of the calf of the leg. In sciatica the pain is seated in the sacro-lumbar region; it is generally of a neuralgic character, is often very severe at night, and always extends along the outer and posterior part of the thigh. The motions of the hip-joint are unimpaired, and the limb retains its natural length and direction.

The joint, in the confirmed stage of the disease, is greatly changed in its structure. Its surfaces, completely denuded of cartilage, are remarkably altered in their shape, and exhibit a rough, porcellaneous appearance. The head of the femur, especially its tip, is reduced in size, and often worn down to a mere stump. Sometimes it is quite conical. The neck of the bone is shortened, unusually horizontal, and eburnized. The acetabulum is deformed, scooped out, and scabrous at its margin. The round ligament is annihilated, while the capsular is thickened and perforated, partially destroyed or hypertrophied and inlaid with bony matter. The muscles around the joint are thin, pale, and flabby. In very old cases, the articular surfaces are frequently connected together by stalactites and osseous bridges.

The changes wrought in this disease are beautifully illustrated in the annexed cut, fig. 621. The head of the femur is greatly altered in shape, the neck is much shortened, and the whole contour of this portion of the bone is in an abnormal condition. The acetabulum is materially reduced in size, and the brim is very rough and elevated into a high ridge.

Fig. 621.
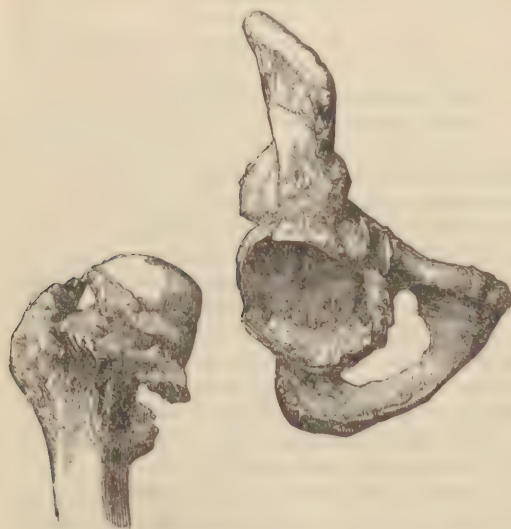
Effects of Chronic Rheumatic Arthritis of the Hip-joint.

Chronic Rheumatic Arthritis of the Knee.—This disease usually begins as an ordinary attack of synovitis. The pain, at first very slight, gradually increases, and is generally most severe at the inner part of the joint, particularly over the inner condyle. The stiffness progresses until, at length, it amounts almost to complete ankylosis; the knee is deformed, and crackles when moved; the hamstring muscles are rigidly contracted; the leg is strongly everted; and the tibia is partially dislocated from the femur. The patella is often considerably displaced, and foreign bodies, or cartilaginous concretions, may occasionally be detected in the joint.

The diagnosis is based upon the chronicity of the disease, the absence of any tendency to suppuration, the marked eversion of the leg, the dislocated appearance of the

knee, the singular condition of the ligament of the patella, which forms a distinct band in front of the joint, and the tuberculated state of the margins of the patella and of the condyles of the femur.

The disease not unfrequently appears at a very early age. I have repeatedly witnessed it in children, especially in boys, before the fifteenth year, and in one instance as early as the twelfth.

Treatment.—To the treatment of this affection, as it occurs in these different articulations, little is to be added to what has already been said in regard to the subject in general. The most important internal remedies, especially in the earlier stages of the attack, after venesection, are mercurial purgatives and anodyne diaphoretics, followed, in due time, by a regular course of alterants, especially the iodide of potassium. In chronic arthritis of the lower jaw the best local means are leeches and a series of small blisters in front of the ears. When the disease attacks the spine, dorsal recumbency will be necessary, and should be observed for a long time, otherwise horrible deformity may be the result. A similar plan of treatment, in addition to the use of splints, will be required when the disease involves the hip, knee, or ankle. The elbow and forearm should be well supported in a sling, when it affects the shoulder. Passive motion, friction, shampooing, douching, and electricity come in play at a later period of the disease, and sometimes afford marked relief. Contracted tendons, muscles, and aponeuroses are divided with the tenotome. When the case is of long standing, all that can be done is to mitigate suffering.

SECT. IX.—ANKYLOSIS.

Several varieties of this complaint are met with, as the complete and incomplete, in the former of which all motion is annihilated, while in the latter motion still exists, although in a very limited degree. There is another form of stiffness, in which the structures of the joint retain their normal characters, but are prevented from being exercised by disease in the neighboring tissues, a circumstance which has induced the division of ankylosis into true and false, or intraärticular and extraärticular. This classification is not only more philosophical than the other, but is of the greatest practical importance, as it leads to a just appreciation of the etiology of the disorder, and also, as a necessary consequence, to proper therapeutic indications. The terms complete and incomplete refer, in fact, merely to different degrees of the same complaint, and might be very well replaced by the words fibrous and osseous, as more expressive of the true nature of the ankylosis.

1. *Intraärticular Ankylosis.*—Intraärticular ankylosis may be produced by whatever has a tendency to excite inflammation in the synovial membrane of a joint, with a deposit of plastic matter upon its free surface. Hence it may arise from all kinds of external injury, as wounds, sprains, blows, and contusions; the presence of interarticular bodies; luxations, especially neglected ones; and fractures which involve the joints, or are situated in their immediate neighborhood. Gout, rheumatism, syphilis, and struma also act as exciting causes; but of all these causes, as well as others that might be referred to, there are none which so frequently occasion ankylosis, permanent and irremediable, as fractures and dislocations. Protracted disuse powerfully disposes to the occurrence of stiffness of certain articulations, especially those of the fingers, wrist, and elbow. I am aware that the force of this influence has been denied, but certainly not upon just grounds; for experience has shown, and my own observation has repeatedly verified the fact, that this circumstance alone is often capable of producing ankylosis of a very obstinate and intractable character. Such an event need not surprise us if we remember that motion is the appropriate stimulus of an articulation, and that more or less of this is just as necessary to its healthy action as food is to the stomach, light to the eye, or sound to the ear. When motion is suspended for any length of time, the synovial membrane becomes dry and stiff, and, eventually taking on inflammation, pours out plastic matter, which effectually obliterates its cavity and so induces permanent ankylosis, on the principle that when the function of a part is destroyed its structure is essentially changed in its character, if not completely annihilated.

All joints are liable to this variety of ankylosis, but it takes place much more easily in the ginglymoid than in the orbicular, and among the former, it is more frequently witnessed in the knee, elbow, and wrist than in any others. Several joints are sometimes involved in the occurrence, especially when it arises from gout, rheumatism, or syphilis; and instances have been noticed in which nearly every articulation in the body was completely ankylosed, the skeleton forming almost one rigid piece.

In every case of intraärticular ankylosis a series of alterations must necessarily take

place before the loss of function can be complete. The first step always consists in the effusion and organization of plastic matter, and the second in the gradual conversion of this matter, first, into fibrous tissue, then into cartilage, and finally into bone, the latter forming the ultimate link in the morbid chain. A fibrous ankylosis generally terminates, at no distant period, in osseous ankylosis, the change from one to the other being regularly progressive until the process is completed, this being the method which nature adopts to effect a cure when any serious accident befalls a movable articulation.

These adhesions and transformations vary in extent, not less than in structure and consistence. Sometimes they are very limited, a considerable portion of the synovial membrane remaining sound, or being only slightly affected by disease, and then the connection between the opposing surfaces is generally easily broken up, so that ultimately the joint may regain its original functions. In a second series of cases, again, the fibrous or fibroligamentous bands are not only more numerous, but they extend from different points of one articular cartilage to the other, and thus either obliterate the synovial cavity, or, at all events, completely destroy its usefulness. Finally, in a third class of cases, the new tissue becomes the recipient of osseous deposits, which, gradually increasing in quantity, in time usurp the place of the synovial membrane and cartilage, and ultimately solder the ends of the two bones firmly together. Hence, if a section be made of what was once the joint, the areolar and solid structures will be found to be inseparably blended, their

Fig. 622.

junction being no longer indicated by the thin layer of compact substance which originally invested their heads. These changes are well seen in fig. 622, from a specimen in my cabinet. The femur and tibia are firmly united to each other and to the patella, the three forming one solid piece.

Treatment.—The treatment of this variety of ankylosis must vary according to the nature and extent of the tissues upon which it depends, and also, in no inconsiderable degree, upon the character of the articulation. When the case is of recent standing, when the adhesions are weak and of limited extent, and when the joint is not too complicated in its structure, a reasonable hope may be entertained that the new tissues may be broken up, and brought fully under the action of the absorbents, so that, in due time, and with proper diligence, the functions of the joint may be measurably, if not completely, reëstablished. Under opposite circumstances, however, a cure will not only be difficult, but generally impracticable.

Much may be done in most cases of intraärticular ankylosis, in the way of prevention, by the steady and persistent use of sorbefacients and passive motion. The attendant inflammation having been divested of its violence, the plastic deposits must be disposed of before they have an opportunity of becoming firmly organized, and

Osseous Ankylosis of the Knee-joint.

the only way in which this can be effected is by frictions with stimulating lotions, aided by the cold or hot douche, and by rubbing the articular surfaces gently against each other, at first once every forty-eight hours, and then once or twice a day, until all the matter has been absorbed, and the synovial membrane has regained its primitive characters. Much more skill and attention are required in these cases than the surgeon is generally able or willing to bestow, and it unfortunately too frequently happens that their entire management is confided to persons who are wholly ignorant of the manner in which it should be conducted. The consequence is that a great deal of harm is commonly done, which it is impossible subsequently to rectify by any mode of treatment, however carefully carried out. For the most part, indeed, the time for successful interposition has gone by when the case falls into judicious hands.

When, through neglect, mismanagement, or unavoidable circumstances, the movements of the joint have become greatly impaired, or when the case has already attained a certain degree of chronicity, instead of abandoning the patient to his fate, an attempt should be made to break up the adhesions by forcible means, not forgetting, however, that they must, nevertheless, be conducted with a certain degree of gentleness in order to prevent mischief. The patient being thoroughly anæsthetized, the distal portion of the limb is

moved with one hand, while the proximal, or that nearest to the trunk, is firmly steadied with the other, at the same time that it rests upon a smooth, solid surface, so as to afford a better fulcrum for the part to move upon. Thus, when we wish to break up the adhesions in ankylosis of the knee, the thigh is firmly pressed upon the table, while the leg, drawn away from its edge, is alternately flexed and extended to as great a degree as may be compatible with safety. In operating on the elbow a similar procedure is adopted, the arm being the fixed, and the forearm the movable point. Much muscular power is frequently required to conduct these movements, and yet the greatest care must be taken so to distribute this power as not to produce any mischief. Not long ago, in one of my cases at the College Clinic, I was so unfortunate, in attempting to remedy an ankylosed elbow, as to fracture the humerus immediately above the joint, the accident being announced by a loud snap, very different from the crackling noise which attends the severance of fibrous bands. The patient, a woman sixty-five years of age, had dislocated her elbow nearly three months previously, and the bone had no doubt become softened and brittle from an extension of the inflammation. Such an occurrence is not always avoidable; for I am very sure that in the case in question much less force was used than I had often employed on similar occasions without any such mishap.

The amount of force and the length of time during which it should be continued must vary according to the circumstances of the case, especially the strength and extent of the adhesions. The efforts should always be very gentle at first, and gradually increased as the parts are found to yield. If the joint be tender, it may be necessary to spend a few days in preliminary treatment, as dieting, purging, and, perhaps, even bleeding. The subsequent managment must be of a strictly antiphlogistic character, and the repetition of the operation must depend upon the effects of the first trial; at all events, it should now be conducted with great gentleness, and rather with a view to a passive than an active result. In many cases it will be found advantageous, after the first efforts, to extend the joint by an angular splint, worked by a screw, and worn steadily until the object is attained, the degree of tension being regulated at will by the patient himself. Apparatus for fulfilling these indications is delineated in the accompanying sketches. Fig. 623

Fig. 623.

Fig. 624.

Kolbé's Apparatus for the Knee.   Modified Stromeyer's Splint for the Elbow.
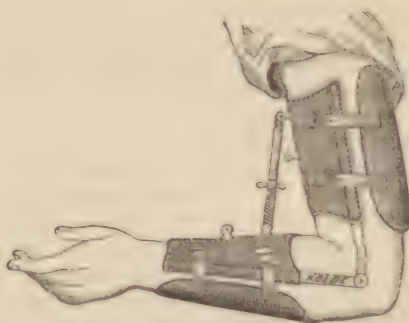
represents Kolbé's contrivance for straightening the knee, and fig. 624 that of Stromeyer for rectifying ankylosis of the elbow.

Of the comparative harmlessness of these operations a good idea may be formed by the statistics furnished by Professor Nussbaum, of Munich. Of 110 cases of forcible extension of the knee, the condyles of the femur gave way in 32, and the tibia just below the attachment of the patella in 7, and yet no evil results ensued in a solitary one. I have myself broken up ankylosed joints in very numerous instances without any serious effects. Nevertheless, all such operations should be conducted with the utmost caution, especially when performed with the aid of machinery, as they may eventuate not only in fracture of the bones, either at the articulation or in its immediate vicinity, but give rise

to consequences still more disastrous, as violent inflammation, erysipelas, gangrene, and even loss of life.

Finally, when it is found that there is no possible chance of effecting a cure, but that ankylosis is inevitable, every effort, compatible with safety, should be made to place the affected limb in a situation most conducive to its future usefulness. Thus, the hand should be extended in a straight line with the forearm in ankylosis of the wrist; the forearm bent at a right angle with the arm in ankylosis of the elbow; and the arm brought close to the antero-lateral aspect of the body in ankylosis of the shoulder. In ankylosis of the hip, the thigh is slightly flexed upon the pelvis; when the knee is concerned, the leg is inclined somewhat backwards; and in ankylosis of the ankle, the foot is placed at a right angle to the leg; the parts being found to be most serviceable when held in these several positions. Particular occupations may, however, render it proper to deviate from these rules. Thus, Mr. Bryant, had under his charge a painter who desired that his arm might be ankylosed in the straight position; and a turner, whose leg, at his own request, was allowed to remain at a right angle with the thigh, as he was thus the better enabled to move his wheel.

Osseous ankylosis of the hip-joint was formerly considered as incurable, except by certain operations, one of which consists in dividing the bone, as originally proposed and successfully executed by Dr. John Rhea Barton, in 1826. His patient, a sailor, twenty-one years of age, had lost the use of his hip-joint, by an injury from a severe fall on shipboard. The thigh was drawn up nearly at a right angle with the pelvis, the knee projecting inwards across the sound limb, and the foot presenting forwards. All attempts at correcting the malposition having failed, a crucial incision was carried through the integument, over the most prominent part of the great trochanter, when, raising the flaps thus defined the muscles connected with this portion of the bone were detached, a passage being thus made both in front and behind the femur for the easy introduction of the finger. With a saw constructed for the purpose, the bone was divided through the great trochanter and a part of its neck in a transverse direction. The wound being lightly dressed, the limb was placed in a fracture apparatus, and the case managed upon strictly antiphlogistic principles. Passive motion was instituted at the end of three weeks, and repeated, from time to time, for four months, when the artificial joint had acquired such a degree of motion that the man was able to walk merely with the aid of a cane. The wound had healed, and he could not only rotate and abduct the foot, but carry it forwards and backwards over an area of upwards of twenty inches. Gradually, however, the use of the new joint was completely lost.

Dr. J. Kearney Rodgers, of New York, in 1830, modified the procedure of Barton, by excising a disk of bone from between the trochanters of a man forty-seven years old. The operation was successful, and the motions of the new joint persisted for two years and a half.

Professor Sayre, in 1862, removed a plano-convex piece of bone from between the trochanters, as shown in fig. 625, from Erichsen, and then rounded off the upper end of the lower fragment, so as to imitate the form of a superficial enarthrodial articulation. One of the great merits of the procedure is the point of transverse section, through which the attachment of the psoas and iliac muscles is preserved for the purpose of flexion. In his first case some necrosis occurred, but six years subsequently the patient enjoyed a good use of the limb. In a second case there was limited necrosis up to the date of the death of the patient from lung complications, six months after the operation, when the parts were found to be furnished with a capsular ligament, articular cartilages, and a synovial membrane.

Fig. 625.

Lines of Section in Sayre's Operation for Ankylosis of Hip-joint.

Of 17 cases of Barton's, Rodger's, and Sayre's open operations, 7 died, and in one performed by Professor Post, and which was an example of the first method, the femoral artery and vein were found on death from gangrene to be hooked over the divided end of the bone. This large mortality, when considered in connection with the extreme rarity with which a movable false joint has resulted, is quite sufficient to condemn these procedures for the simpler and more successful subcutaneous osteotomies.

Professor Volkmann, in 1873, modified the procedure of Rodgers, by making an incision along the posterior face of the great trochanter, separating the periosteum for two-thirds of its circumference, and removing with chisels and gouges

a triangular piece from just below the trochanter, and then forcibly breaking the inner circumference of the bone, after which he brought the limb parallel to the longitudinal axis of the body, and retained it in this position until consolidation had taken place. Of twelve operations conducted by Volkmann in this way, under antiseptic precautions, all recovered.

Mr. William Adams, of London, in 1870, reported the case of a man, twenty-four years of age, upon whom he had some months previously successfully performed subcutaneous division of the neck of the thigh-bone within the capsular ligament, on account of ankylosis of the hip-joint attended with extreme deformity. The instruments employed were a long tenotomy-knife, and a narrow saw with a cutting edge an inch and a half in length, fig. 626. After the section of the bone in the direction shown in fig. 627, it was necessary to divide the tendons of several of the femoral muscles in order to straighten the limb. The wound was slow in healing; but no severe inflammation or deep suppuration followed the operation, and bony ankylosis, with the limb in a straight position, was obtained. Of 34 cases in which this operation has been performed, only 3 proved fatal, one from pyemia, one from profuse suppuration, and one after consecutive amputation at

Fig. 626.

Fig. 627.

Adams's Saw for Subcutaneous Division of the Neck of the Femur.

Showing the Point where the Neck of the Femur is Divided in Adams's Operation.

the hip-joint. The procedure is particularly adapted to those cases in which the head and neck of the bone preserve their normal size, as when the ankylosis is the result of rheumatism or injury. Instead of making a clean section of the bone with a saw, Billroth resorts to the chisel and forcible fracture.

When the neck of the femur is materially altered in form, or partially destroyed, changes which frequently occur in tubercular osteitis, the shaft of the bone should be divided subcutaneously with Adams's saw just below the lower trochanter, as was originally practised by Gant, in 1872; or the section may be made with the chisel, as recommended by Maunder, the former instrument, however, being preferable. The procedure is comparatively safe, having been uniformly successful so far as I have have been able to learn. Under similar circumstances, Barwell prefers to make an oblique section, begining just above the small and terminating a little below the middle of the square face on the outer aspect of the great trochanter. Both of his patients recovered with useful limbs.

The most recent of the operations for the relief of bony ankylosis of the hip-joint, is that of Volkmann, which consists in forming a false-joint in the following manner: An incision having been made along the posterior surface of the great trochanter, the bone is divided one inch below the upper border of that epiphysis, the interior of the neck of the femur is fractured, and the head of the bone is removed by scooping out the interior of the acetabulum with a gouge. The upper end of the femur is next rounded off with a chisel and reduced in diameter to the size of the shaft of the bone, and then placed in the cotyloid cavity. The limb is subsequently extended by weights, and early passive motion resorted to. Volkmann has resected the joint in this way six times, and all the patients were enabled to walk and sit without elevating the pelvis.

The operation of Dr. Barton, above described, was modified by him, in 1835, in such a manner as to render it particularly applicable to the relief of deformity of the lower extremity, dependent upon *ankylosis of the knee-joint*. The case was one of complete bony ankylosis, in a medical man whose leg was flexed nearly at a right angle with the thigh, and who recovered with an excellent use of his limb.

The operation, as performed by Dr. Barton, consists of four distinct stages. In the first, a triangular flap is formed of the soft parts in front of the limb, consisting of the integument and the extensor muscles, by making two horizontal incisions, one just above the superior border of the patella, and the other two inches and a half higher up, down to the bone. This flap, which has a broad base on the inside of the thigh, is then dissected up, and held out of the way. The next step is to remove a V-shaped portion of

the femur, which is easily done with a narrow saw, care being taken not to divide the bone completely, for fear of injuring the popliteal artery, as happened in a case reported by Professor Ried, of Jena. In the third stage the bone is fractured by gently extending the limb; and, lastly, the flap is replaced and secured by suture. The dressing is completed by putting the limb upon a double inclined plane, where it is retained for the next ten days, or until the ends of the broken bone are enveloped in plastic matter, when it is placed nearly in the straight position, in a suitable apparatus for insuring quietude. The patient is usually able to rise, and walk about on crutches, in six weeks, or much sooner, if the immovable dressing is applied.

The sawing of the bone constitutes one of the leading objects of interest in this operation; if the wedge-shaped piece is too large, there is a possibility of non-union, whereas, if it is too small, it may be impracticable to straighten the limb sufficiently. In order to avoid these contingencies, all that is necessary is to measure the angle of deformity, and then to saw out a portion of bone equal to the complement of that angle. The adjoining cut, fig. 628, will afford a better idea of the nature of the operation than any description of it, however elaborate.

Dr. J. Kearney Rodgers modified this operation by connecting the ends of the bone with silver wire, on the supposition that the procedure would tend to expedite their reunion.

Fig. 628.

Barton's Operation.

Such a measure, however, is hardly required if proper care be taken to keep the limb well secured during the after-treatment.

Of 16 cases of this operation, of which the results have transpired, 14 recovered and 2 perished, respectively of hectic irritation and exhaustion. The success would thus seem to be eminently flattering.

In 1844, Dr. Gurdon Buck, of New York, in a case of complete synostosis of the knee with the limb at a right angle, so modified and extended the procedure of Barton as to remove the condyles of the femur, the head of the tibia, and the patella, in a wedge-shaped piece, thereby bringing the leg almost in a straight position. The patient, a man twenty-two years of age, suffered considerably from subsequent inflammation and suppuration; but at the end of six months the bony union at the knee was firm, and the limb shortened five inches. This operation has been practised in 39 cases, of which 5 proved fatal. The best result obtained from it, was in a case reported by Dr. Heuser, in which firm, osseous union took place in ten weeks, the man being afterwards able to pursue his vocation of a chamois hunter.

An operation for the relief of bony ankylosis of the knee, based upon the same principles as that of Dr. Barton, but differing from it in some essential particulars, was performed by the late Professor Pancoast at the Clinic of the Jefferson Medical College in the winter of 1859, the patient being a youth on whom extension had previously been tried in vain. It consisted in perforating with a stout gimlet the femur subcutaneously, through a single opening, at half a dozen points, just above the knee, and then forcibly breaking the bone. The limb was placed in appropriate apparatus, the upper end of the inferior fragment forming an angle with the apex projecting into the ham. A large abscess formed at the seat of fracture, but, with this exception, the case progressed favorably, and the boy made a good recovery, the foot coming down well, and the limb being nearly as straight as could be desired in such a condition of the knee-joint. In a case in the hands of Professor Agnew extensive suppuration also ensued, but the lad, after much suffering, finally got well.

An operation similar to the above was performed by Professor Brainard, in 1860, upon a man twenty-three years of age; but in this case the femur was divided through its condyles by means of a perforator. The patient recovered with a good limb. In a second case, one of false ankylosis of the knee, the patella was detached subcutaneously from the femur and tibia, and excellent motion of the joint obtained.

The operation of perforating the femur subcutaneously, and then forcibly fracturing the bone, has been performed only, so far as I know, in six instances, all of which recovered with useful limbs.

In 1861 I extended these subcutaneous operations to perforation of the joint itself, with disruption of the osseous adhesions between the bones entering into its composition. The instrument with which the operation is conducted, exhibited in fig. 629, consists of
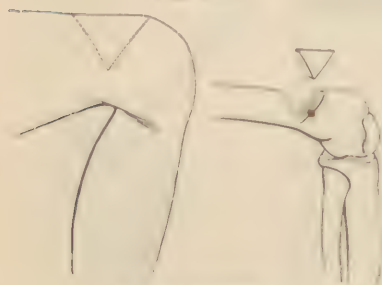
a shaft of well-tempered steel, four inches and a half in length, the point of which is one-sixth of an inch in breadth, and presents on each side an oblique groove with cutting edges, so that it acts as a gouge as well as a drill. This is fitted into a firm handle, its proximal extremity being large, smooth, and rounded, so as to rest comfortably in the palm of the hand. In some instances, as when the bony connections are so firm as to resist the action of the drill, a narrow, sharp-pointed chisel, or Adams's saw may be used as a substitute. Whatever may be the form of the instrument, great caution must be exercised in operating on the posterior surface of the joint, lest it slip and injure the popliteal vessels.

The following case, transcribed from my clinical records, exemplifies the mode of performing the operation, the trifling suffering which generally follows it, and the after-treatment. A man, twenty-two years of age, was admitted into the hospital of the Jefferson Medical College, on the 30th of October, 1861, on account of bony ankylosis of the left knee, the leg being flexed at nearly a right angle with the thigh. Nine years previously, while engaged in mowing, he accidentally opened the joint with a scythe, the injury being followed by violent inflammation and constitutional disturbance. During his prolonged confinement, the limb was placed in a very bent position, in which it became stiffened, compelling him to use a crutch. A scar marked the site of the original wound, and the integument about the joint was indurated, and the seat of the cicatrices of old sinuses.

Fig. 629.

Bone-Perforator.

The diagnosis was synostosis of the knee, and was based on the absolute immobility succeeding traumatic inflammation, a fixed state of the patella, a sensation to the touch of thorough consolidation of the articulation, the absence of tension and resistance of the flexor muscles on attempts at forcible extension, and freedom from pain both in front and behind the joint during similar efforts.

Chloroform having been administered, a longitudinal incision, hardly half an inch in length, was made over the outer surface of the knee, near its middle, in a line with the groove between the head of the tibia and the external condyle of the femur, down to the two bones. Through this opening the drill was introduced, and passed on to the opposite side, when it was moved about in such a manner as to cut through and break down the osseous connections between the femur and the tibia on the one hand, and the femur and the patella on the other. The union was exceedingly firm; but after much difficulty, it was finally overcome, and by forcible extension of the limb, the parts yielded with a crackling noise. The small wound was carefully closed with two twisted sutures and collodion, and a roller carried from the toes to within a short distance of the groin. The leg was brought to an angle of about 45° with the thigh, and laid in an easy position upon its outer surface, a thick pillow being placed behind the knee. No blood was lost in the operation, and no pain experienced. Half a grain of sulphate of morphia was administered as soon as the effects of the anæsthetic had passed off, and recumbency, light diet, and cooling drinks enjoined.

No constitutional disturbance followed the procedure, the entire immunity from suffering being, doubtless, due to the fact that the natural structures of the joint had been completely destroyed. For four days the limb was allowed to remain perfectly quiet, when an extending apparatus was applied, and the leg was straightened daily several degrees. On the tenth day when the dressings were removed, the wound was found to be perfectly united, and at the expiration of three weeks the patient was permitted to go about on crutches. In the sixth week he was discharged well. At this time bony union was firm, the knee being slightly flexed, and the leg shortened one inch.

Fig. 630.
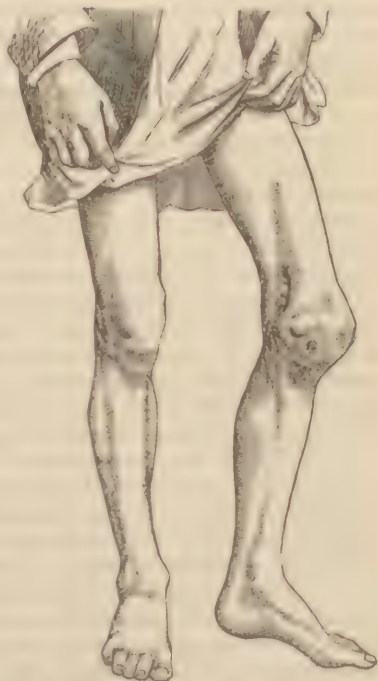
Result of Operation for Synostosis of the Knee.

The adjoining sketch, fig. 630, from a photograph, exhibits the appearance of the limb, two years after the operation. The muscles were as plump and as well developed as in the sound member.

This operation has been done successfully in seven instances, five having occurred in my own practice. In two of the latter preliminary division of the hamstring tendons was demanded, and in all firm bony union was procured with about one inch of shortening, which was deemed advisable to render locomotion less awkward. The treatment was not any longer than that required for simple fracture of the femur, the mean duration of confinement in bed having been twenty-three days, and the average length of time, in which the patient was unable to walk without artificial aid, ten weeks. In only one instance was the resulting traumatic fever alarming, and its occurrence could only be referred to the fact that the synostosis was not complete. The operation, indeed, should only be performed when the ankylosis is osseous throughout, as this renders the joint perfectly tolerant of rough interference. In such cases the synovial membrane and cartilages are destroyed, and the bones forming the articulation are firmly soldered together, as it were into one continuous piece, as in fig. 622, page 1092. Under ordinary circumstances, where the bond of union is soft, or the ankylosis false, and the least particle of motion is preserved, so rude a procedure would be attended with great risks, if not followed by fatal results, and could not be too strongly condemned.

2. *Extraärticular Ankylosis.*—In extraärticular ankylosis, the spurious ankylosis of some authors, the articular structures retain, at least for a time, their normal characters, but their functions are impaired or suspended by the diseased condition of the surrounding parts. Several distinct causes may induce such a result, of which muscular contraction, vicious cicatrices, osseous deposits, and the pressure of new growths, or aneurismal tumors, and paralysis of the articular muscles, are the most common and efficient.

a. Of the several causes here enumerated as capable of producing rigidity of a joint, permanent contraction of the muscles and tendons, which naturally influence and control its movements, is the most frequent. Examples of this are constantly met with in gout, rheumatism, fractures, and dislocations, where, from an extension of the inflammation which attends these diseases and accidents, motion is greatly impeded, if not completely destroyed, by this occurrence. The influence exerted by permanent contraction of the muscles is well illustrated in clubfoot and analogous distortions, where the joints are not only crippled in their functions, but greatly changed in their form and relations, giving the limb that peculiar aspect, from the resemblance to which it derives its name. Similar effects may be caused by the contraction of the aponeuroses.

β. Secondly, a joint may become stiff from a vicious cicatrice, as that, for instance, of a burn or scald. The tendency of the new substance is to continue to contract until in many cases it produces the most hideous deformity, stretching the soft parts to their utmost capacity, and drawing the neighboring articular surfaces completely out of their natural position. The morbid adhesions formed after ulcerative ptyalism generally give rise to distressing and often irremediable ankylosis of the temporo-maxillary articulation.

γ. In gout, rheumatism, and other affections, as well as in certain accidents, the motions of the joints are occasionally destroyed by the formation of osseous bridges, extending across the articulation from one bone to the other. Such an occurrence is most frequently met with in the sacro-iliac symphyses, and in the joints of the vertebræ; it sometimes occurs also in the more perfect joints, especially the ginglymoid. In fractures, followed by exuberant callus, the muscles and tendons, in the vicinity of the neighboring joint, may be so completely imprisoned by the new matter as to cause ankylosis of the worst kind.

δ. Ankylosis may be produced, in greater or less degree, by the development of various kinds of tumors, or morbid growths, in the neighborhood of an articulation, or in direct contact with it, interfering with its functions, and ultimately, if not removed, perhaps annihilating them. Thus, an aneurism of the popliteal region may cause stiffness of the knee, and a sarcoma of the jaw, partial ankylosis of the the temporo-maxillary joint.

ε. Finally, paralysis of the muscles of a joint may induce a certain degree of ankylosis; cases are constantly observed where, from long disuse of an articulation from this cause, its functions are permanently lost. The shoulder-joint frequently becomes stiff and useless, from palsy of the deltoid interfering with its natural movements.

It is extremely probable that the most of the causes here enumerated may, if long continued, induce permanent ankylosis, in consequence of the operation of the general pathological law, that, when a part ceases to perform its functions, it gradually degenerates, and is ultimately completely deprived of its characteristic attributes. Nature abhors everything

that is useless, and, when a joint is once rendered passive, the synovial membrane, losing its secreting faculty, becomes dry, and is at length converted into fibrous tissue.

The *treatment* of extraärticular ankylosis must be regulated by our knowledge of the nature of the exciting cause, which should, therefore, always be clearly ascertained before any attempt be made to interpose any curative agents. Thus, if it be found to depend upon contraction of the muscles, tendons, or aponeuroses, whether singly or unitedly, the only remedy, in confirmed cases, is their subcutaneous division ; whereas, in recent cases, it may often be relieved by a course of friction, douching, and passive motion, aided by gentle exercise on the part of the patient. Vicious cicatrices must be cut out, and, if possible, replaced by new substance ; such a procedure, however, is not always practicable, and, therefore, most cases of this description proceed from bad to worse until they are rendered wholly irremediable. Osseous bridges, circles, or bands may occasionally be removed with the saw and pliers ; morbid growths are exsected, or, as in aneurism, the artery leading to it is tied ; and paralysis of the muscles is relieved by stimulating frictions, the cold douche, shampooing, and electricity, the general health being at the same time improved by tonics, alterants, and exercise in the open air.

SECT. X.—NEURALGIC AND HYSTERICAL AFFECTIONS.

The joints are occasionally the seat of neuralgia, although not nearly so often as is generally imagined, especially if it be regarded as an independent lesion. As a complication of coxalgia and other articular affections it is sufficiently frequent. It is not improbable that in many of the cases in which it is referred to the joints, it is in reality situated altogether exterior to them, in the structures immediately around, and not in those directly concerned in their composition. Its most common sites by far are the knee and hip. As an independent affection, neuralgia is most frequent in young, delicate, nervous females, soon after the appearance of the menses, of the derangement of which it is occasionally an exponent. No period of life, temperament, habit, or occupation, however, is exempt from it. The attacks are sometimes strictly periodical, precisely like those of an intermittent fever, coming and going regularly once a day, or every forty-eight hours ; but more frequently they are irregular, the patient being tormented nearly incessantly, the pain being now slight, now severe, and then, perhaps, again entirely absent, although never very long at one time. The paroxysms are often coincident with neuralgia in other parts of the body, alternating with it, usurping its place, or going on with it simultaneously. The pain is either of a dull, heavy, aching character, or sharp, lancinating, and darting, flying about in fits and starts, in different directions, almost with the rapidity of lightning. It is usually attended with more or less soreness and tenderness on pressure, motion, and percussion, and sometimes with a slight degree of tumefaction or puffiness of the parts around the affected joint, which often entirely disappears in the intervals of the attacks. Motion also is usually somewhat impeded, and, when the hip is involved, there may even be considerable deformity of the lower part of the spine and of the pelvis. In the more aggravated cases the whole limb may be swollen, tender, and disabled ; and then there is commonly also a sense of numbness, extending to the very extremity of the member. The general health is not always appreciably affected ; often, however, there is marked disorder of the digestive organs, with a sallow state of the skin, headache, constipation, and derangement of the renal secretion. In the female the symptoms are often of an hysterical character, and are liable to frequent exacerbations in consequence of the peculiar state of the mind, which is generally morbidly sensitive, and absorbed in selfishness and disagreeable forebodings.

It is of great moment to discriminate carefully between neuralgic and other affections of the joints, inasmuch as a wrong diagnosis may lead to serious errors in practice, inducing, perhaps, the employment of harsh measures when gentle alone are required ; or, on the other hand, allowing the patient to move about and exercise the joint when he ought to observe the most perfect quietude. In general, the history of the case, the peculiar nature of the pain, the suddenness of the attack, the absence of constitutional disturbance, and the perfect freedom of motion of the affected joint, when the surgeon takes hold of the limb and attempts to carry it about in different directions, especially when the patient is under the influence of anæsthesia, will serve to distinguish it from organic disease of the articulations. When, however, there is any doubt respecting the real nature of the complaint, the examination should be repeated again and again, and

varied in every possible manner, so as to elicit the true state of the case. In many instances the best diagnostic is the success or failure of antineuralgic remedies.

In the *treatment* of articular neuralgia the first object should be to ascertain, if possible, the nature of the exciting cause, and then to direct our remedies accordingly. Attention to the diet, bowels, and secretions should, throughout, be kept prominently in view. The malady very often has its origin in a vitiated state of the alimentary canal, or in the suppression of some important habitual discharge, by correcting or restoring which the symptoms frequently disappear without any further effort. In general, however, antineuralgic remedies, properly so called, will be needed, and of these the best, unquestionably, are quinine, strychnia, and arsenious acid, in doses varying from three to five grains of the first, with the sixteenth of a grain of the second, and the tenth of a grain of the last, three times daily. When there is marked evidence of anemia, iron may be advantageously combined with these articles. If, on the other hand, the patient is plethoric, from the sixth to the eighth of a grain of tartar emetic may be added to each dose, with a view to its relaxing and diaphoretic effects. Morphia also forms a valuable adjuvant, and can rarely be dispensed with. Colchicum often proves very serviceable, affording prompt relief when everything else fails. It is particularly valuable when the disease partakes of a rheumatic or gouty character.

As topical remedies the most reliable are, soap liniment, with a liberal addition of laudanum and chloroform, kept constantly upon the part with a piece of flannel; the steam of hot water, conveyed to the joint from a tube connected with a boiler near the bed; frictions with atropia, veratria, or aconite ointment; and the employment of electricity. Leeches may be used when the articulation shows evidence of being inflamed, although they will generally be found to afford only very transient relief. Motion of the affected limb, especially in protracted cases, is usually highly beneficial, and should not be neglected.

The *hysterical* form of this affection appears to be much more common in England than in America, where, judging from personal observation, it is quite infrequent both in town and country. Sir B. C. Brodie, who was the first to call attention to it, declares that, among the higher classes of society in London, at least four-fifths of the female patients, supposed to labor under disease of the articulations, labor merely under hysteria. The pain, generally excessively severe, is aggravated by the slightest motion and pressure, and is usually confined to one particular spot, from which, however, it is liable to shift to other points. It is frequently associated with exquisite morbid sensibility of the surface, and is commonly located, not in the joints, but in the parts around them; often, indeed, apparently in the skin, or in the skin and muscles. Spinal irritation often exists, the extremities are cold, the pulse is small and feeble, the countenance is pale, the breathing is, at times, much embarrassed, the bowels are irregular, and the stomach is oppressed with flatulence. The disease is most common in young girls soon after the age of puberty.

Intense pain is sometimes experienced in the joints, especially in the ilio-femoral, as a result of endometritis. A probe introduced into the womb causes excessive suffering, darting with the rapidity of lightning into the hip, groin, and pelvic region. Occasionally a certain amount of tumefaction exists, but, generally, the parts have a perfectly normal appearance, and hence the true nature of the case is seldom fully comprehended by the professional attendant.

In the treatment of this disease assafetida and valerian often prove highly efficacious, especially if combined with chalybeate tonics. When the disease is associated with disorder of the menstrual function, great advantage will generally accrue from an occasional aloetic purge and the steady use of the compound iron mixture. Bromide of potassium, in large doses, is an excellent remedy, particularly serviceable in cases attended with loss of sleep and general nervous disorder. Chloral, too, often affords great and immediate relief. In many cases these two articles may be advantageously exhibited together. Monobromide of camphor, in doses of three to five grains, twice a day, occasionally affords marked benefit, and is sometimes highly efficacious. The cold bath, change of air, residence at the sea shore, and exercise on horseback, are often serviceable in effecting relief. Brodie relates a number of cases in which the disease was almost cured by an accident, as a fall or blow upon the affected articulation. The suffering of the joints, dependent upon endometritis, always promptly disappears upon the removal of the exciting cause.

SECT. XI.—DISLOCATIONS.

1. GENERAL CONSIDERATIONS.

A dislocation, or luxation, is the sudden and forcible removal of one articular surface from another, either as an effect of external violence, of inordinate muscular contraction, or of a diseased condition of the component structures of the affected joint.

As all joints are necessarily composed of two or more bones, the question naturally arises, which should be considered as the luxated one? Upon this subject all surgical authorities are, I believe, agreed. In every accident of this description the bone nearest the trunk is regarded as the fixed bone, and the one articulated with it as the dislocated. Thus, in luxation of the shoulder-joint, the scapula retains its normal position, either actually or suppositiously, while the humerus is thrown off the glenoid cavity, at one time in this direction, and at another in that. In dislocation of the elbow, the ulna and radius are forced away from the humerus, the latter serving as the fixed point. The same rule obtains in regard to all the articulations of the inferior extremity.

Dislocations are divisible into simple and complicated, complete and incomplete, primitive and consecutive, recent and old, single and double. When the accident occurs before birth it is designated by the term congenital.

A luxation is said to be simple when it is unaccompanied by anything more than a slight rupture of the ligaments, or of the ligaments and muscles. Although such an accident is usually produced by external force, as a blow or fall, it may occasionally arise purely from muscular action, especially when it is favored by disease of the affected joint.

In a complicated dislocation there is, in addition to the loss of relation between the two contiguous surfaces, some serious lesion of the soft parts, as, for example, a wound communicating with the displaced bone or opening directly into the articulation, laceration of important vessels or nerves, contusion of the skin and muscles, or fracture of the luxated bone. When the wound penetrates the affected joint, the accident is usually called a compound dislocation.

A complete luxation is one in which the head of a bone, totally removed from its corresponding articular surface, effects a lodgment in a new situation, as, for instance, when the head of the humerus is forced down into the axilla, resting against the border of the scapula, below the glenoid cavity. In an incomplete luxation, on the contrary, the articular surfaces, although they have lost their relative position, remain still partially in contact with each other.

In primitive dislocation, the displaced bone remains in the position into which it was originally forced; in consecutive, it abandons its first situation, and is fixed in another. Such an accident, however, can only happen, as a rule, when the luxation depends upon some organic disease of the articular surfaces, allowing them gradually to separate from each other, either by the mere weight of the corresponding limb, or by the action of the neighboring and associated muscles. In the traumatic form of the injury such an event must be exceedingly rare, although we must admit its possibility, the dislocating agent forcing the bone at once to the greatest verge of its displacement; or, as not unfrequently occurs, its further progress is effectually arrested by some opposing osseous prominence or some tensely strung soft part, as a tendon, muscle, or fibrous membrane. Luxation of the knee-joint from caries of the articular surfaces furnishes a characteristic exemplification of these two kinds of displacement. In this accident the head of the tibia gradually forsakes the condyles of the femur, slipping back into the popliteal region, whence, in time, it is drawn up against the posterior surface of the bone by the flexor muscles, thus suffering secondary luxation. A similar occurrence, although exceedingly uncommon, may, nevertheless, happen in a very robust subject in traumatic dislocation of the hip, shoulder, or lower jaw, where the force is barely sufficient to lift the head of the bone out of its socket upon, but not over, its rim, from which it is afterwards removed either by mere muscular contraction, or by the conjoint influence of this and the weight of the part connected with the displaced bone.

The terms recent and old refer merely to the duration of the injury, and might seem, at first view, to require no particular explanation. The propriety of this, however, will be rendered at once obvious if the question be asked, when does a dislocation become old? does it become old in a few days, or weeks, or months? So far as mere time is concerned, no lesion of this kind can be regarded as old unless it has existed for at least from six to twelve months; but if we look at the subject in reference to the ability of the

surgeon to restore the affected joint to its natural relations, it will be found that, while one dislocation may not be old at the end of several months, another may become so within the first few weeks. Thus, a luxated shoulder may frequently be successfully reduced after a lapse of two months, or even considerably later, whereas if an attempt be made to restore a dislocated elbow at the end of one-third or even one-fourth of that time, signal failure will generally follow. The import of these two terms, then, is one of much greater importance than has commonly been admitted, having, practically considered, a positive value and significance.

A single dislocation is one in which only one joint is involved; in the double form of the accident, on the contrary, the corresponding joint is likewise affected. The lower jaw suffers more frequently in the latter way than any other bone, but a similar displacement is also occasionally witnessed in the humerus, ulna, radius, clavicle, femur, and fibula. Double luxations may be complete or incomplete, simple or complicated.

Joints which admit of varied and extensive motion are much more prone to this injury than such as enjoy only a very limited motion. Hence, what are called the ball and socket joints, of which those of the hip and shoulder are the best representatives, suffer much oftener than the ginglymoid, as those of the elbow and knee. The tables of Malgaigne prove that dislocations of the shoulder are more frequent than those of all the other movable articulations together, 321 cases out of 481 having occurred here. Comparing the relative proportion of cases in the two extremities, the same distinguished observer finds that they are seven times more numerous in the superior than in the inferior. These differences in the relative frequency of the lesion in different joints are, as already stated, clearly referable to the differences in their structure and functions. Of all the large articulations, that of the shoulder is the most insecurely constructed; the glenoid cavity is remarkably shallow; the capsular ligament is long and loose, and the joint, admitting of every variety of motion, is under the direct influence of numerous powerful muscles, and exposed to numerous accidents. Why, then, should it be surprising that it is so often the seat of dislocation? The hip-joint, on the contrary, is the most admirably contrived joint of which it is possible to form any conception; as a piece of mechanism it is perfect; the acetabulum is an immense socket, in which the whole head of the femur is literally buried, and to which it is still further secured by two powerful ligaments, the round and the capsular; and, in addition to all this, it is surrounded by numerous large muscles, which serve to support and protect it from injury. Thus constituted, this articulation is comparatively seldom the seat of dislocation, hardly, as compared with that of the shoulder-joint, in the proportion of 1 to 9½. The clavicle, which enjoys only a very limited degree of motion, is not unfrequently luxated, its exposed situation and its buttress-like office rendering it peculiarly prone to the accident, occupying, in this respect, nearly the same rank, according to Malgaigne's statistics, as the hip-joint.

Thus, recapitulating what is said above, it may be concluded that the most powerful predisposing causes of dislocation are, varied and extensive motion of the joints, want of firmness between the articulating surfaces, arising either from their shallowness or the structure and arrangement of their ligaments, and the exposed situation and peculiar functions of the bones entering into their composition.

The direction in which dislocations occur is subject to much diversity, depending upon the nature of the joint, and the direction in which the force is applied at the time of the accident. In the ginglymoid articulations the bones may be displaced backwards, forwards, or to either side; in the orbicular, as, for example, that of the shoulder, downwards, forwards, upwards, or backwards.

Although dislocations occur at all periods of life, they are by far most common in middle-aged and elderly persons. Of 643 cases, analyzed by Malgaigne, only one was noticed before the fifth year, and none after the ninetieth. The greatest number took place between the thirtieth and fifty-sixth years. The reason of these differences is to be found in the circumstance that the bones of the young subjects, being comparatively soft and pliant, and not yet everywhere completely solidified, yield most easily at their epiphyses and even at their shafts, while those of very old and decrepit persons are generally so brittle that it requires much less force to break than to luxate them. It is seldom that an opportunity is afforded of seeing a dislocation of the hip-joint after the age of sixty, while it is very common to meet with fracture of the neck of the femur within the capsular ligament. This statement, however, must be received with some degree of restriction, for it is obviously not applicable to all the articulations. The shoulder-joint, for instance, forms a striking exception, its dislocation in old age being much more frequent than fracture of the superior extremity of the humerus.

Causes.—The efficient causes of dislocation are external injury and muscular contraction. Most cases are due to the former, acting either directly upon the joint, or indirectly through some bone articulated with it. Dislocation of the shoulder, consequent upon a blow or fall upon its summit, affords a good illustration of the manner in which injury acts when applied directly to an articulation. In this case the force is spent upon the superior extremity of the humerus, propelling the head of the bone down into the axilla, beyond the glenoid cavity of the scapula. The femur may be luxated in a similar manner, by a heavy body falling on the hip, while the thigh is in a state of abduction. Lateral dislocation of the patella is another instance of displacement occasioned by direct violence. Sometimes a severe wrench is necessary to produce the accident, especially when the bones are connected by short and strong ligaments, requiring great force to separate them.

A more common mode of causing this accident is by the indirect application of force. Indeed, nearly all the dislocations of the upper extremity, and many also of the lower, are the result of violence, transmitted from the distal portion of the limb, and concentrated upon some particular bone, which thus loses its connection with the opposing surface. It is in this manner that falls upon the hand so often luxate the elbow, and even the shoulder, according to the point upon which the violence is exploded. Dislocation of the clavicle is usually induced by falls upon the shoulder, in which this bone is acted upon by two forces coming in opposite directions, the one being caused by the weight of the body, and the other by the object struck.

Of the ability of the muscles to induce this accident, experience has furnished ample proof. I have myself witnessed a number of examples of it, mostly in the shoulder, during attacks of epilepsy. In one, the accident occurred simply by raising the hand above the level of the head. Yawning is a common cause of dislocation of the lower jaw. Several cases have been recorded of displacement of the thigh-bone by muscular contraction. In the ginglymoid joints such occurrences must, for obvious reasons, be much less frequent than in the orbicular.

Some persons possess the power of dislocating certain joints voluntarily, simply by muscular action. Several such individuals have come under my own observation, but it was invariably noticed that, however powerfully they exerted themselves, they could not produce anything like a complete displacement of the articular surfaces, and it is, therefore, presumable that most of the examples that have been reported of this occurrence have been of this description. Dr. Haynes, of Saranac, New York, has published the particulars of the case of a lad, seven years old, who is said to be able to luxate, and also to reduce, the joints of the knee, elbow, wrist, thumb, and fingers, with perfect ease, by muscular contraction.

Fig. 631.

Dislocation of the Knee from Disease.

In all cases of dislocation, whether the result of direct or indirect injury or of muscular contraction, the accident is materially favored by a partial separation of the articular surfaces. The lower jaw cannot suffer displacement so long as it is closed, but if the chin be struck while the body is depressed, and the condyle drawn forward upon the anterior convex part of the temporal fossa, the slightest blow will suffice to throw the bone down over the root of the zygomatic process. Dislocation of the humerus into the axilla is greatly promoted by abduction and elevation of the arm. The femur is generally luxated upwards and backwards against the dorsal surface of the ilium, by falls upon the hip, and

the occurrence is always greatly facilitated by the circumstance of the patient having a heavy load on the back. A twisted or contorted state of the limb is generally highly conducive to the accident.

Organic disease of a joint may become a cause of dislocation, as seen in fig. 631. from a patient of Professor T. G. Richardson. The man had labored for a long time under an arthritic affection of the knee, which was gradually followed by permanent displacement of the head of the tibia backwards behind the condyles of the femur. There was no external disease of any kind. The head of the bone could easily be reduced, but not kept in position, owing, apparently, to the complete destruction of the ligaments of the joint.

2. SIMPLE DISLOCATIONS.

Dislocations are characterized by a certain train of symptoms, by which they may generally be easily distinguished from other accidents. Of these symptoms, the most constant and prominent are, loss of function of the affected articulation, lodgment of the displaced bone in an unnatural situation, deformity of the joint, and change in the mobility, length, and axis of the corresponding limb. To these may be added, as subordinate phenomena, the noise which is occasionally heard by the patient at the moment of the accident, numbness of the parts from pressure of the luxated bone upon the nerves, contusion and discoloration of the integument, together with pain, swelling, and crepitation as effects of the resulting inflammation.

Immediate and, generally, entire loss of function of the affected joint is a necessary consequence of a dislocation, however induced. Thus, in luxation of the temporo-maxillary articulation, the lower jaw is widely separated from the upper, and cannot be closed by any effort that the patient may make. When the principal joints of the upper extremity are affected, the person is unable, without assistance, to carry his hand to the head, or to execute the motions of flexion, extension, circumduction, pronation, and supination ; the whole limb feels heavy and numb, and requires to be supported by the sound one. In dislocation of the foot, leg, and thigh, progression is not only impracticable, but every attempt of the kind is attended with so much distress as to cause its immediate discontinuance. The loss of function necessarily persists so long as the joint remains unreduced, although, eventually, it is generally completely regained.

Impairment of the motion of the corresponding limb is an important symptom. The patient, in general, not only loses all voluntary control over the member, but the surgeon, upon taking hold of it, and attempting to carry it about in different directions, finds it impossible to effect his object. Motion, it is true, is not always completely abolished, but there is no case in which it is not considerably, if, indeed, not greatly, restricted. In some of the articulations, as, for example, in that of the elbow, the displaced bones are occasionally so thoroughly interlocked as to render it difficult, even by the most adroit and persevering efforts at extension and counterextension, to disengage them from each other, and restore them to their natural situation. Immobility, therefore, is one of the most valuable symptoms of dislocation. Its causes are threefold, muscular contraction, opposing osseous prominences, and constricting ligamentous bands, or all these united. A knowledge of these obstacles is of great practical moment, as it involves important therapeutic considerations, which cannot be too well understood.

In most cases the surgeon is able to feel the displaced bone in its new situation, beyond the limits of the corresponding articular surface. Sometimes, indeed, it may even be readily detected with the eye, by the prominence which it forms by raising up the muscles and integument. In order to ascertain the precise position of the bone, a careful examination will generally be required, especially when there is much tumefaction obscuring the symptoms. For this purpose one hand is placed upon the injured joint, while the other is employed in moving the corresponding limb ; when greater accuracy is necessary, this office is confided to an assistant, in order that both hands may be used for conducting the investigation. If the manipulation be productive of severe pain, it should be suspended until the system has been brought fully under the influence of anæsthesia. The distance to which the head of the displaced bone is thrown varies, in different cases, from a few lines to several inches, depending upon the size and shape of the joint, and the amount of force employed in producing the accident ; as a general rule, it is greater in the orbicular than in the ginglymoid articulations.

Deformity of the joint is commonly one of the most reliable symptoms. It usually manifests itself in a marked flattening of the articulation, as in dislocation of the humerus into the axilla, in which there is always a loss of rotundity of the cushion of the shoulder

from the manner in which the deltoid muscle is spread out ; or, in great increase of the width of the joint, as in lateral luxation of the elbow and knee. Sometimes the joint has a singularly contorted, angular, or twisted appearance.

A marked change in the length of the limb articulated with the displaced bone is generally present. It is seldom that the limb retains entirely its normal length ; most commonly this is either increased or diminished, the extent varying according to the structure of the joint and the degree of force employed to produce the accident. Shortening is the rule ; elongation the exception. Thus, in the various luxations of the shoulder and hip there is only one in each in which the limb is increased in length, while in all the rest it is considerably, if not greatly, shortened, amounting in some of them to several inches. No material difference exists in regard to this symptom in the dislocations of the orbicular and the ginglymoid articulations.

Dislocation changes not only the length of the affected limb, but also, in most cases, its axis, giving it a peculiarly contorted or twisted appearance. This deformity is nowhere more conspicuous than in the displacements of the elbow-joint, in some of which it is almost diagnostic. Another excellent illustration of this occurrence is afforded in luxation of the head of the humerus into the axilla, where this trait is often so well marked as at once to convince the practised eye of the nature of the accident. In most of the displacements of the orbicular joints the limb stands off at a considerable distance from the body, in a constrained and twisted state.

Of the subordinate symptoms there is not one that is of any actual value ; nevertheless, they are deserving of some consideration, if for no other reason than that of completing the history of this accident.

It is highly probable that most dislocations, at least those of the larger joints, are attended with some degree of noise at the moment of their occurrence ; but that this noise is not often heard by the patient may be assumed from the fact that he is so seldom conscious of it, owing to the confused state of mind into which he is thrown by the sudden and unexpected nature of the accident. Its character cannot be easily described, but it may, perhaps, be said to bear a closer resemblance to a crackling sound than any other to which it can be compared. It is, apparently, caused by the sudden and forcible separation of the articular surfaces, and is generally most distinct in luxations of the orbicular joints.

A considerable degree of numbness is occasionally felt in the parts immediately around the affected joint, and even in the whole of the corresponding limb. It evidently depends upon the compression of the nerves by the displaced bone, and is particularly distressing in the axillary dislocation of the shoulder, in which the tingling sensation often extends to the very tips of the fingers.

More or less contusion and discoloration are often present. The contusion may be accompanied by scratches of the skin, or even by considerable wounds, thus complicating the case. The discoloration varies from the slightest change of the normal hue to deep purple, depending upon the size and number of the injured vessels. Large quantities of blood are sometimes effused among the tissues in the immediate vicinity of the affected joint and even into the joint itself.

The pain consequent upon dislocations varies greatly in different individuals, often depending, perhaps, quite as much upon their idiosyncrasy as upon the severity of the injury. Its immediate cause, of course, is the rupture of the ligaments and other structures in and around the affected joint, and may, on the one hand, be so excessive as to induce fainting and other distressing effects, or, on the other, so insignificant as hardly to attract attention. It is always increased by manipulation and motion, as well as by the resulting inflammation, and may continue for days and weeks. In nervous, irritable subjects it occasionally assumes a neuralgic character. When the displaced bone compresses an important nerve, the pain is generally attended with a feeling of numbness and tingling.

More or less swelling always succeeds to dislocations ; sometimes almost instantly, but generally not under several hours ; at one time slight, at another exceedingly severe. When it appears suddenly, within a few minutes after the accident, it is always due to effusion of blood, and is then either attended or soon followed by discoloration of the integument. Coming on more slowly, it may reasonably be concluded to be the result purely of inflammatory deposits, especially of serum and lymph, or of these deposits and of blood combined. When the incited action runs very high, the swelling is generally proportionately great, the part being hard, stiff, glossy, painful, and intolerant of manipulation.

The friction-sound which occasionally attends recent unreduced dislocations has been ascribed to different causes; by some, as J. L. Petit, to dryness of the articular cartilages; by others, to the presence of a superabundance of synovial fluid; by Sir Astley Cooper, to a deposit of fibrin in the joint and the neighboring bursæ; by Malgaigne, to the rubbing of the head of the luxated bone against an osseous surface denuded of its periosteum. I am strongly inclined to the belief of the English surgeon that it is mainly, if not wholly, due to plastic effusion into and around the articulation, an idea strengthened by the fact that it can never be elicited until after the occurrence of inflammation. If it were occasioned by dryness of the articular cartilages, or denudation of the bone, it ought, as a natural consequence, to be perceptible immediately after the infliction of the injury.

The term friction perhaps expresses the nature of this sound better than any other that can be employed; it is entirely different from the grating noise and sensation caused by rubbing together the two ends of a broken bone; it is more like the sound occasioned by rubbing over each other two pieces of sole-leather; it is a soft, creaking, or crackling noise, not a grating one.

Diagnosis.—The accident with which dislocation is most liable to be confounded is undoubtedly fracture, especially fracture in the vicinity of the articulations, an occurrence not only quite frequent, but generally exceedingly embarrassing, on account of the difficulty of its diagnosis. The most constant and reliable symptoms of dislocation, as already stated, are, deformity, both of the affected joint and limb, loss of function, impaired motion, and difficulty of restoring the displaced bone to its natural situation. In fracture the most important characters are, distortion, preternatural mobility, and crepitation, with facility of reduction.

If these symptoms be compared with each other, it will be found that, although there is some resemblance between some of them, yet that, in the main, they are strikingly dissimilar, and, therefore, in so far, diagnostic of the accidents which they respectively serve to characterize. Deformity is common to both dislocation and fracture, and, for this reason, is of little, if any, value as a point of distinction between them. The same is true of the loss of function, which is often, perhaps generally, quite as great in the one as in the other. If a man with a luxated hip may occasionally support the weight of his body upon the affected limb, or even walk slightly upon it, he can sometimes do as much, and even more, when he has an impacted fracture of the femur, or a fracture of the neck of that bone temporarily unattended by a separation of the fragments. A dislocated jaw is quite as helpless as a broken one; in neither case can it perform the office of mastication. Both these symptoms, then, are without the slightest diagnostic value. But it is very different with the others above enumerated. Mobility, for example, is a differential sign of great significance. In dislocation, mobility is either entirely lost, or very much impaired; the displaced bone is more or less firmly fixed in its new situation, and can only be restored to its natural position by more or less powerful efforts, often long and anxiously continued. In fracture, on the contrary, there is always an increase of motion, or, more properly speaking, there is preternatural mobility, the limb allowing itself to be bent, extended, and even rotated upon its axis. Moreover, by extension and counterextension the member may readily be restored to its natural length and shape, but the moment these efforts are discontinued there is a reproduction of all the previous symptoms. Such an event never happens in dislocation; a bone once reduced remains reduced, unless accident should again lift it out of its socket. Lastly, in luxation the replacement is usually attended with a peculiar noise or snap, caused by the forcible contact of the opposing surfaces; in fracture no such noise is ever distinguishable. Crepitation is another valuable diagnostic in these accidents. In dislocation the only sound ever perceived is a kind of friction-sound, and even this is never present until after the supervention of inflammation; in fracture, on the contrary, crepitation is one of the most important symptoms; indeed, it is characteristic of the lesion. It may be detected immediately after the accident, and during all stages of the after-treatment up to the time of incipient union. Deformity and preternatural mobility may both be absent, and yet if there be crepitation, or a rough grating noise and feel upon rubbing together the ends of the broken bone, there can be no doubt respecting the real nature of the case. It is a fracture and nothing else. So, on the other hand, if there be deformity and loss of motion, with absence of crepitation, the rational inference is that the case is one of luxation, or, at all events, not of fracture.

Another valuable sign, but one which has only a general application, is the difference in the position of the affected limbs in the two classes of injuries. In dislocation the limbs often stand off at a considerable distance from the body, in a constrained and un-

seemly attitude; in fracture, on the contrary, they always hang close by the side of the body. Most of the displacements of the hip and shoulder joints exhibit this peculiarity, and I consider it as of no little value as a means of discriminating between these lesions and fractures of the superior extremities of the femur and humerus.

Contusion, discoloration, pain and swelling being common to both dislocation and fracture, are worthless in a diagnostic point of view. Instead of being of advantage in this respect, they generally only serve to embarrass the attempts at discrimination. Numbness, however, possesses a certain value, especially in some of the luxations of the shoulder and hip, where it occasionally constitutes a prominent and distressing symptom, which is never the case in fracture, except under very rare circumstances, as when the ends of the broken bone pierce, bruise, or compress a large nerve.

Important aid may sometimes be derived from a knowledge of the position which the dislocated bone is most liable to occupy. Thus, in displacement of the shoulder, the head of the humerus is usually thrown into the axilla, or forwards against the chest, seldom upwards or backwards; the most common luxations of the femur are those upon the dorsal surface of the ilium and into the sciatic notch. In the ginglymoid joints, especially those of the knee and elbow, posterior displacement is most common.

After all, however, no matter what may be the character or prominence of the symptoms, a correct and reliable diagnosis can only be attained by a thorough examination of the condition of the parts concerned. Without the light which such an investigation is capable of furnishing, no surgeon, however skilful or experienced, can always be certain whether the accident is really a dislocation or a fracture, or whether these lesions do not coexist. In conducting the examination, the same general rules are applicable as in fracture. The sooner, of course, it is made, the less likely will it be to occasion severe suffering to the patient, or annoying embarrassment to the practitioner. When the parts have become tumid and infiltrated, the nature of the accident is usually very much obscured, and the manipulation only aggravates the already existing mischief. Besides, they will then be so painful as to render it impossible to touch them unless the patient is under the influence of an anaesthetic. It is unnecessary to say that when a joint is in this condition, it must be handled with the greatest care and gentleness; yet, at the same time, the exploration should be thorough, otherwise it cannot be satisfactory, and if one trial is not sufficient, another should be made soon after the first, means being used, meanwhile, to allay pain and inflammation, in order to render the parts more tolerant of manipulation.

A careful measurement of the affected limb, or, rather, of the portion of the limb, between the affected joint and the one next below, often throws valuable light upon the diagnosis. Thus, if, in injury of the shoulder-joint, the distance between the acromion process and the elbow is found to be considerably greater than on the sound side, it will be a legitimate inference that the case is one of dislocation into the axilla, and not of fracture of the head or neck of the humerus. In luxation of the elbow backwards, the forearm is always sensibly shortened in front, while behind it retains its normal length. The measurement must be taken with a piece of tape, which, in order to insure greater accuracy, should always be graduated, the ends being applied against two fixed points, and the same operation being performed upon the sound limb.

When, notwithstanding all these examinations and precautions, the case remains doubtful, it will be well to adopt the suggestion of Malgaigne of inserting a long, slender needle into the joint, and also, if necessary, into the parts immediately around, with a view of ascertaining their precise condition. If a hollow be found where there is naturally a projection, or a projection where there ought merely to be a cavity, it may reasonably be presumed that the case is one of dislocation, and the conjecture will be converted into certainty if there be an absence of crepitation and preternatural mobility. There can be no possible objection to such an exploration, if due attention be paid to the larger vessels and nerves, and if the instrument be sufficiently slender to make only a small puncture, and so well tempered as not to break. It is surprising, when we consider the facility and safety of this operation, and the undoubted light which it is capable of affording in obscure cases of this accident, that it has not attracted more attention, or been more frequently employed.

Finally, dislocations are sometimes painfully simulated by sprains, so much so, indeed, as to puzzle and perplex the most sagacious observer. In such an event, nothing short of the most patient and accurate examinations and measurements, repeated again and again, both in the recumbent and in the erect posture, will be likely to prevent mistake.

Morbid Anatomy.—On dissecting a joint that has been recently luxated, the head of the bone will be found to be more or less removed from its socket, the distance to which it has been thrown ranging from a few lines to several inches, according to the structure of the parts involved, and the degree of force concerned in producing the accident. In the incomplete form of the lesion the articular surfaces still partially retain their apposition, while in the complete all connection is lost. The displaced head rests either upon some muscle, tendon, or bone, or upon all these structures, and the socket is generally occupied with blood, either fluid, or partly fluid and partly coagulated. The ligaments are lacerated, elongated, and relaxed, the extent of the rent varying from a mere fissure, barely large enough to permit the escape of the bone, to almost complete separation from their osseous attachments. The capsular ligaments are usually more extensively torn than the band-like, and, in both cases, shreds of the injured structure are occasionally interposed between the bone and the parts upon which it rests. In dislocations from muscular contraction, as in those of the jaw and shoulder, slight laceration of the ligaments is generally conjoined with marked elongation, and dissection has rendered it probable that cases of this kind occasionally occur even without any rupture whatever. The muscles in the immediate vicinity of the injured articulation usually participate, at least to some extent, in the mischief sustained by the ligaments, being, like them, more or less stretched, contused, or even torn, although the latter occurrence is neither frequent nor extensive. The nervous trunks around the joint may be compressed and displaced by the luxated bone, but are rarely, if ever lacerated, or seriously hurt in any way. The same is true of the larger vessels, both arterial and venous, the hemorrhage which follows the accident, and which is usually quite insignificant, proceeding from the smaller ligamentous, connective, and muscular branches. If the patient has survived the accident several days, so that the parts have had time to become inflamed, more or less plastic matter will be found, both in the socket and in the neighboring tissues, matting and gluing them together.

Prognosis.—The prognosis of simple dislocations must be considered with reference to two circumstances, the restoration of the displaced bone, and the severity of the injury sustained by the accident. If attended to early, they may commonly be easily reduced, and are seldom dangerous either to life or limb. If, however, they are neglected, or improperly managed, more or less deformity and loss of motion must ensue, and the resulting inflammation may be so great as to cause serious constitutional disorder. Luxations of the orbicular joints are generally less hazardous than those of the ginglymoid, but they are nearly always more difficult of reduction, on account of the adjacent muscles being more numerous and powerful, and, consequently, more resisting. On the other hand, however, the displacements of the orbicular articulations retain their reducibility much longer than the ginglymoid ; thus, a luxated shoulder may often be restored at the end of several months, whereas a luxated elbow generally becomes irreducible within as many weeks. In children, old persons, and females, the restoration is generally more easily accomplished than in adults, or in strong, robust individuals, whose muscles are more developed, and, therefore, less easily subdued. This difference obtains, in the same relative degree, even when anæsthetics are used.

Treatment.—The leading indications in the treatment of simple luxations are, first, to restore the articular surfaces as soon as possible to their natural situation ; secondly, to keep the affected joint at rest until the lacerated ligaments and other structures have become repaired ; thirdly, to limit and subdue inflammation ; and, fourthly, to reëstablish the functions of the parts. The character of these indications, and the mode of fulfilling them, should be kept clearly and prominently before the eye of the practitioner ; for, unless he has accurate and definite conceptions upon the subject, he must often fail in accomplishing his object in a satisfactory and creditable manner.

In entering upon the consideration of the treatment of this class of accidents, the first question that arises is, what are the causes which oppose their reduction, or, in other words, why is it that dislocations do not disappear of their own accord? Until recently it was generally supposed that the principal barrier to the reduction was the resistance offered by the muscles connected with the displaced bone, contracting at first spasmodically, and then permanently, so as to hold the part firmly in its new position. To overcome this action of the muscles in the vicinity of the affected joint has, therefore, always been a leading indication in the attempts at reduction ; and yet how signally these attempts frequently fail, after the most thorough relaxation, not only of these muscles, but of the whole system, by anæsthetics and other means, as the lancet, tartar emetic, and the warm bath, is well known. This fact of itself, then, is sufficient to prove that, although muscular contraction is one of the main agents which oppose the reduction, it is not by any

means the only, nor always even the principal, one. If the difficulty depended merely upon the resistance of the muscles, whether spasmodically acting or temporarily shortened, the use of depressants and anaesthetics, aided by steady, persevering extension and counter-extension, ought to enable the surgeon to reduce, promptly and effectually, every dislocation whatever. But this is not the case; the patient, in former days, used to be bled to syncope, nauseated to the utmost with tartar emetic, and literally parboiled, and yet, half dead as he was, restoration was frequently impossible, and so it is still in these days of chloroform and ether. This, then, being the fact, other opponents, capable at least of aiding the muscles in their resistance, or of themselves sufficient to offer a serious, if not insuperable, barrier to the reduction, must be sought for. Such obstacles are found in the bones and ligaments, and but for these it would be difficult to conceive of any case of dislocation that could resist, more than a few minutes, any well-directed efforts at restoration. In truth, almost every dislocation would reduce itself. Why is it that the surgeon frequently experiences so much trouble in replacing a luxated thumb? Is it not because of the resistance offered by the prominences and ligaments of the affected joint? The muscles of the thumb can certainly not, as active agents, exert any serious influence in preventing the reduction; for cases have occurred where the luxated phalanx was literally torn away in unsuccessful attempts of this kind. In dislocation of the jaw, the principal obstacle to the reduction is the zygomatic process of the temporal bone; and, although the temporal, pterygoid, and other muscles usually contract with great power, yet this would rather tend to favor the reduction than to prevent it if the condyle of the bone were not firmly locked in the fossa below. The obstacle which bony prominences offer to replacement is well shown in the luxations of the shoulder and hip, the former being always comparatively easy of reduction, on account of the smooth and shallow state of the margin of the glenoid cavity, while the latter, in consequence of the opposite state of the rim of the acetabulum, are generally comparatively difficult. This resistance, however, is always, other things being equal, most striking in the ginglymoid articulations, owing to the greater complexity of their structure, and their larger size, but more especially to the greater number and bulk of the neighboring prominences and depressions, thus permitting the displaced bone to become more readily interlocked with the fixed one.

The most serious barrier to reduction is generally offered by the ligaments, caused by the small size or the peculiar shape of the rent made at the time of the accident, the bone passing readily through it, but being unable to return on account of the manner in which it is girt by the edges of the aperture; the membrane or cord being drawn over its neck like a purse with a tight string, or a button fastened in its hole. That this frequently happens in the capsular ligaments, in luxations of the orbicular joints, may readily be imagined when we take into consideration the difficulty of effecting reduction, however thoroughly the system may be relaxed, while, in regard to the funicular ligaments, or those of the ginglymoid articulations, the fact is abundantly attested by daily experience.

Finally, it is extremely probable that the reduction of certain dislocations is materially impeded, if not at times prevented by the head of the displaced bone becoming entangled among the neighboring muscles or tendons, producing an effect similar to that occasioned by the ligaments and bones.

The means which are usually employed for surmounting these several obstacles consist of certain manipulations or manoeuvres, as extension and counterextension, conjoined, if necessary, with pressure and thorough relaxation of the system.

Occasionally mere pressure, if properly directed, is sufficient to effect reduction, especially when the dislocation is seated in a joint with loose ligaments, or when the ligaments are extensively lacerated and the neighboring muscles are in a passive, crippled, or paralyzed condition. In general, however, more or less extension and counterextension will be required, and the mode of applying and conducting these becomes, therefore, a matter of paramount consequence. Upon these subjects much diversity of sentiment has existed among writers, some contending for one mode of practice, and others for another, as if it were possible to lay down any specific rules upon points of treatment which must necessarily vary according to the exigencies of each particular case. My own experience is that it is generally best to apply the extending power to the bone which is articulated with the luxated one, or, in other words, as far as possible from the site of injury. Many practitioners, however, select the distal portion of the displaced bone, under the supposition that it affords a more direct and influential leverage. In not a few instances, indeed, we are obliged to adopt this course from necessity, the nature of the case not admitting of any choice; as, for example, in dislocations of the wrist and elbow, and in the corresponding dislocations of the inferior extremity.

Extension and counterextension may be made by the hands of intelligent assistants, aided, if requisite, by lacs, napkins, sheets, or pulleys. As a general rule, the resisting power, or the counterextending means, should be fully equal to the extending, and both should be applied in such a manner as to create as little inconvenience and pain as possible; they should be exerted slowly and gradually, and at the same time continuously, the object being not to fret the muscles which oppose the reduction, but to fatigue and exhaust them. Indeed, any sudden and violent movements would only be followed by mischief. With regard to the extension, it should always be first made in the direction of the luxated bone, but in proportion as the resistance is overcome the limb should gradually be brought back to its natural position.

During the reduction the patient may sit or lie, as may be most convenient, or as the exigencies of the case may seem to demand. Whenever chloroform is administered, recumbency is indispensable. The patient, as a general rule, should lie upon a bed or table during the reduction of nearly all the dislocations of the principal articulations, especially those of the shoulder, hip, and knee; in those of the elbow, hand, ankle, clavicle, and jaw, on the contrary, the sitting posture will be found most convenient for the surgeon. The number of assistants must vary from one to three, four, or five, according to the nature of the case, and it will be of great benefit if their duties are always accurately defined before the operation is entered upon, otherwise delay, annoyance, and embarrassment will be sure to arise. The counterextending band, which generally consists of a folded sheet, a jack-towel, or, what is better, a long, stout piece of muslin, is fastened around the trunk or limb so as to diffuse its pressure over a considerable space, without the risk of injuring the soft parts, exciting the muscles in the neighborhood of the dislocation, or interfering mechanically with the return of the luxated bone. The extending band must also be secured with great care. The best plan is to envelop the surface of the limb to which it is to be applied with a soft, wet napkin, folded, and passed around at least twice. This answers the double purpose of protecting the skin and of preventing the noose or lac from slipping, which seldom fails to happen if a dry cloth be

Fig. 632.
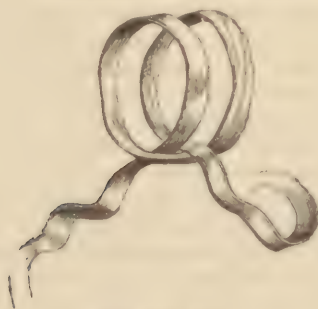
Fig. 633.

Clove-hitch Knot.

Fig. 634.

Compound Pulleys.
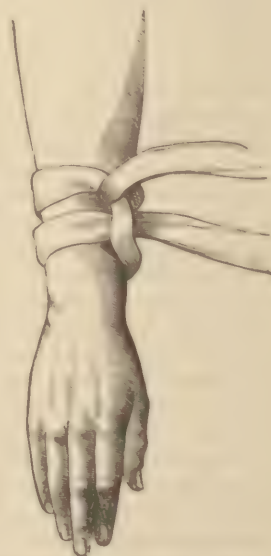
Clove-hitch Knot Applied.

used. The lac should be of sufficient strength not to break, and should be fastened around the napkin by means of the clove-hitch or sailor's knot, the proper method of making which will readily be understood by a reference to the accompanying sketches, figs. 632 and 633. Or, instead of this, we may use the French knot, which is equally efficient, and which is executed by placing the band across the limb so as to form a loop on each side, each end being then passed under the limb through the opposite loop. In

the more simple forms of dislocation, the requisite extension and counterextension may be made with the hands, or by the pressure of the heel, knee, or fist.

Pulleys, fig. 634, are rarely required for reducing dislocations, the use of anæsthetics and

Fig. 635.

Pulleys applied.

the " manual method," as it is termed, having well-nigh rendered their application unnecessary in all recent cases of the accident. I have myself not had occasion to employ them for many years, and there is reason to believe that, as we become better acquainted with the nature of the subject, they will ultimately be almost entirely dispensed with. There is no doubt that they have done immense mischief, even in the hands of otherwise judicious surgeons, and that they more frequently impede than favor reduction. A formal description of this instrument will be unnecessary here, as its appearance and office, known to every one, will easily be understood from the annexed representation, fig. 635. During its application the patient should be recumbent, one hook being fastened to a staple, fig. 636, in the floor or wall, and the other to the noose in the lac encircling the limb. The cord should then be tightened, either by the surgeon himself, or by a trustworthy assistant, the operation being performed with all possible care and gentleness, so as not to endanger fretting of the muscles, fracture of the bones, or rupture of any of the soft parts.

Fig. 636.

Staple.

To prevent the slipping of the pulley-rope, and at the same time distribute the pressure so as not to bruise the limb, recourse may be had to the ingenious contrivance, fig. 637, devised by Dr. Levis. " It consists," says Dr. Roberts, " of a strong iron hook, the upper part of which is attached to a flat plate about seven inches long and two wide. This plate is slightly curved transversely

Fig. 637.
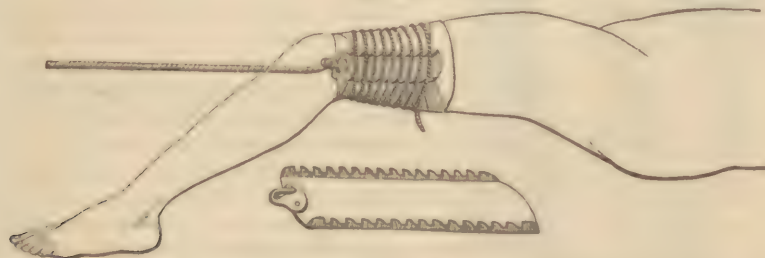
Levis's Apparatus for fastening Pulley-rope to Limb.

to apply itself to the limb, and is roughened. On the upper surface of this plate, at each side, there extends a serrated longitudinal ridge in which the cord attaching the plate to the extremity is caught as it encircles the limb." The contrivance answers equally for the upper extremity.

A very ingenious contrivance, serving as a ready and efficient substitute for the pulleys, has been suggested by Dr. Fahnestock, of Pittsburgh. It consists in the use of a thin but strong rope, from four to eight strands of which are passed under the extending band, and doubled upon themselves. The free extremities are then drawn tightly, and secured

to a staple in the wall. A stick is next carried across the centre of the strands, and revolved upon its axis as a double lever. In this manner a single assistant may furnish any amount of power that may be necessary for gradually and steadily overcoming muscular action, while the surgeon himself attends to the dislocated bone. The annexed cut, fig. 638, affords a good illustration of the apparatus applied to the subject.

Fig. 638.

Fahnestock's Method of Extension and Counterextension.

Another instrument of great power is the dislocation-tourniquet, fig. 639, of Mr. Bloxam, of London, which, although it acts upon the same principle as the multiplying pulleys, is a more convenient as well as a safer contrivance capable of affording great aid in drawing the bone into its natural position in cases of unusual muscular resistance.

Fig. 639.

Bloxam's Dislocation-Tourniquet.

Of the surgical adjuster of Dr. Jarvis little need be said here. I have never employed it in recent dislocations, and in the repeated trials which I have made with it in those of somewhat long standing it has not been my fortune to meet with any marked success. It is an instrument of extraordinary power, and should, therefore, be used with great care and discretion. In the hands of its ingenious inventor it has doubtless been productive of benefit. Fig. 640 represents the adjuster as applied for the reduction of a dislocation of the hip-joint.

As the resistance of the muscles is one of the chief barriers to the reduction of dislocations, means, to which the term auxiliary is applied, are generally at once resorted to with a view to its counteraction. These means are both local and constitutional, and are particularly necessary in strong, robust individuals. The most efficient remedies of this class, formerly at the disposal of the surgeon, were copious blood-letting, usually carried to syncope, nauseating doses of tartar emetic, the warm bath, and the liberal use of anodynes. Sometimes the disgusting practice of intoxication by alcoholic liquor was pursued; and Dr. Physick occasionally advised the smoking of tobacco to bring about the desired relaxation. Since the introduction of chloroform and ether nearly all such means have become obsolete, these articles having very properly taken their place. Even bleeding is now seldom necessary, except occasionally where, from

excessive muscularity of the patient, unusual difficulty is expected, or where, from the injury sustained by the soft parts, it is important to employ at once active measures for preventing excessive inflammation. Tartar emetic, the warm bath, and tobacco enemas have justly been proscribed. The patient is anæsthetized in the usual manner, and all manipulation is withheld until the system is completely relaxed and the mind rendered unconscious, when the operation is at once proceeded with, the action of the remedy being maintained until the object is accomplished. I have pursued this practice in ever case of dislocation that has fallen under my notice during the last thirty years, and have every reason to be satisfied with the result.

Fig. 640.
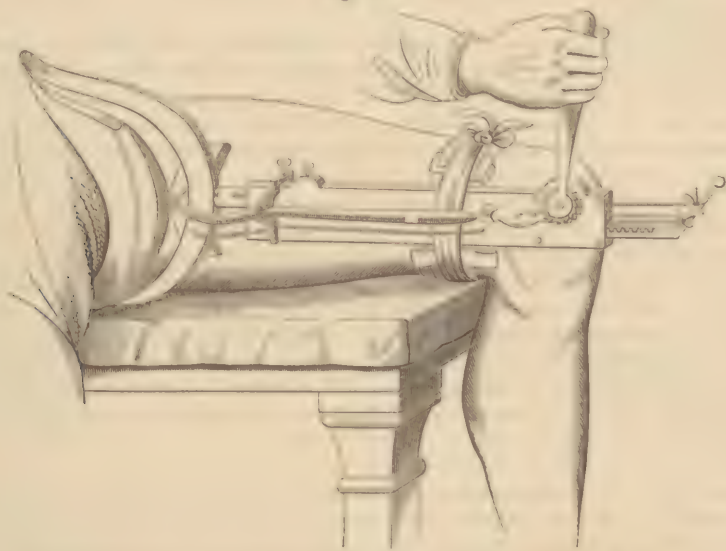
Jarvis's Adjuster, applied for the Reduction of a Dislocation of the Hip-joint.

A surgeon, called to a case of dislocation immediately after its occurrence, may occasionally succeed in effecting replacement by taking advantage of the faint and relaxed state in which he finds the patient from the shock he has sustained. Or he may succeed by diverting his attention, either by engaging him in conversation, or by a sudden expression of surprise, while he makes a forcible attempt at reduction. The mere idea of pain is generally sufficient to excite the muscles to spasmodic action, so as to oppose the efforts at restoration. It was, therefore, formerly a matter of great consequence to prevent this by a playful remark, an impertinent question, or an angry reply, designed to distract the attention of the sufferer, and to throw the muscles off their guard. Dupuytren is reported, upon one occasion, to have employed a similar, although less polite, expedient. Having been called to a lady of rank on account of a dislocation of the shoulder, he was for a long time foiled in his efforts; the assistants pulled, he pushed and pressed, and she shrieked and offered every possible resistance. His temper became ruffled, and he tried in vain to distract her attention. At last, said he, "Madam I have repeatedly asked you how this accident happened, and you have as repeatedly deceived me; you have not informed me that you had been drunk." The woman, shocked at the remark, indignantly asked, "Who told you so?" "Your son, madam." The poor patient was stupefied, all the muscles became instantly relaxed, and in a moment the luxation was reduced.

When an anæsthetic is used, the surgeon effects the reduction either by his own personal efforts, or he employs such aids as the exigencies of the case may seem to require. When the extension and counterextension have been maintained for some time, bringing thus the head of the displaced bone gradually nearer and nearer to its socket, he should grasp the part firmly, and thus assist in lifting it into its natural position. Or he may accomplish this by means of a band or fillet thrown across his neck and shoulder, while he makes strong and steady pressure against the head of the bone, pushing it back in the direction of the luxation or towards its fellow. In many cases the reduction will be facilitated if, at the moment the bone approaches its socket, the limb is rotated upon its axis, carried towards the body, or drawn over the opposite limb. When the replacement is

unusually troublesome, the ingenious surgeon will not fail to employ all kinds of expedients and stratagems to accomplish his object, rather than abandon the patient to his fate with a useless limb. It is now well ascertained that almost every recent simple dislocation may be effectually and expeditiously reduced by manipulation alone, especially if the patient is completely anæsthetized. Difficulty will be likely to occur only, or chiefly, when the head of the bone has slipped through a very narrow opening in the connecting ligament, grasping the bone with extraordinary firmness, and so impeding its return to its proper position.

The restoration of the dislocated bone is indicated by the reëstablishment of the shape and motion of the joint; by a snap or noise heard at the moment of the reduction, but which is always very faint when the patient has been anæsthetized; and by a great and sudden diminution of pain.

Finally, it is always very desirable to effect replacement as speedily as possible, even although there should be considerable inflammation and swelling, and, consequently, a probability of inflicting some pain; for it is much better to do this than to subject the patient to the risk of having, by the delay, an irreducible dislocation, of which there must alway be some apprehension, especially when the injury involves a ginglymoid articulation. An exception to this rule must, of course, be made when the joint is excessively swollen and tender, when a few days may be profitably spent in the employment of leeches and saturnine and anodyne lotions, antimonials, and other means, until the inflammation is sufficiently reduced to render the parts tolerant of the necessary manipulation.

In obstinate cases of dislocation, rendered so by the manner in which the bones are interlocked with each other, and in which the muscles passing over them are stretched like tense cords, the reduction is sometimes greatly facilitated by subcutaneous tenotomy. The expedient is particularly valuable in dislocations of the tarsal joints, but it may also be advantageously employed in displacement of the larger articulations, especially in those of long standing. The operation has often been successfully performed, without, so far as I am aware, having been followed by any bad results. Care must, of course, be taken to avoid interference with important structures.

After-treatment.—When the reduction is completed, measures must be adopted, first, to prevent a recurrence of the accident, and, next, to limit inflammation, more or less of which must necessarily take place after every injury of this kind, however simple. The former of these objects is accomplished by appropriate bandages, or bandages and splints, with rest in the recumbent posture, especially if the injury be seated in the lower limbs; in dislocations, on the contrary, of the upper extremity, the arm should be suspended in a sling, and the patient, after a few days, be permitted to walk about in the open air. Inflammatory accession is met by the usual antiphlogistic remedies, both constitutional and topical, among the latter of which evaporating lotions, as alcohol and water, and solutions of acetate of lead, along with laudanum, are the best, and they will generally be found most agreeable and beneficial, at least during the first forty-eight hours, if applied warm. The joint, if favorably situated, is supported with a roller to assist in moderating effusion and swelling. Its effects, however, must be carefully watched, otherwise it may occasion undue constriction. Pain is subdued with full doses of morphia.

Finally, every means should be employed to guard against the occurrence of ankylosis. With this view passive motion should be instituted as soon as the inflammatory symptoms have abated, and repeated, steadily and perseveringly, at first once, and afterwards twice, or even thrice, a day, until the functions of the joint are perfectly reëstablished; an object which can seldom be attained, in any case, under several months, and in some, indeed, not under six, ten, or twelve, depending upon the nature of the joint, the extent of the injury, the character of the treatment, and, above all, the coöperation of the patient, whose conduct has often much more to do with the production of a stiff and useless joint than that of his surgeon. After the more prominent inflammatory symptoms have disappeared, the absorption of effused fluids should be promoted by soap liniment, or moderately stimulating embrocations, followed, in due time, by the cold douche, dry frictions, massage or shampooing.

3. COMPLICATED DISLOCATIONS.

A complicated luxation, as stated elsewhere, is one in which the displacement is accompanied by a fracture, the rupture of an important vessel or nerve, a violent contusion, or a wound communicating with the cavity of the articulation, or extending deeply among the tissues in its neighborhood. Not unfrequently several of these lesions coexist, thus materially increasing the gravity of the case, and the difficulty of managing it.

Although such an accident may occur in any of the articulations, it is by far more frequently met with in those of the elbow, knee, and ankle than in any other, for the reason, probably, that the heads of the bones are less protected there by muscles, and also that they are more sharp or angular, than in the orbicular joints. Hence, when the injury is unusually violent, the articular extremities, losing their ligamentous connections, are apt to be impelled with so much force against the soft parts as to lacerate them from within outwards, dividing muscles, tendons, fasciæ, vessels, nerves, and integument, and, perhaps, protruding several inches beyond the external wound; or, the vulnerating body, impinging forcibly against the external surface, may commit the mischief from without inwards, the bones being comparatively passive until the moment they are struck, when they, in their turn, may inflict additional injury upon the structures beyond where the projectile does not penetrate. In the great majority of instances, at least in civil life, the lesion is caused by falls, blows, or kicks; in military practice, by gunshot injury.

Compound dislocations, as they are commonly called, that is, dislocations in which there is a wound opening into a joint, are very rare in comparison with simple. Thus, of 94 cases of dislocations, reported by Dr. Norris as having occurred in the Pennsylvania Hospital, only 2 were compound; and of 166 cases collected by Professor Hamilton, only 8 were of this description.

The *symptoms* of complicated dislocations are usually so characteristic as not to require any formal description. In general, there will be more or less distortion of the joint, inability of motion, discharge of synovial fluid, and shortening of the corresponding limb, with contusion, discoloration, and ecchymosis of the soft parts. In case there is a wound, the end of the bone not unfrequently protrudes at the external opening; sometimes to a distance of an inch or more. Crepitation will be likely to be present when the dislocation is complicated with fracture. Great numbness and partial paralysis will indicate lesion of an important nerve; while coldness of the extremity, with absence of pulsation in its distal portion, and copious extravasation of blood, will be denotive of serious injury of the principal artery.

A complicated luxation, as the name implies, is always a grave accident, often jeopardizing the safety alike of limb and life. The resulting inflammation is generally extremely violent, and is peculiarly prone to lead to abscess, erysipelas, and pyemia, especially in persons of intemperate habits, or of a dilapidated system. Under such circumstances, and sometimes even when the health was most perfect immediately before the injury, the constitutional disturbance is usually very great, delirium sets in early, and the parts are soon seized with gangrene. The danger of mortification will necessarily always be proportionately great when there has been a division of an important vessel or nerve, interrupting circulation and innervation; pyemia will be most likely to occur when there has been excessive shock, and necrosis when the protruded or exposed bone has been stripped of periosteum, splintered, or covered with dirt. But the danger to limb and life is not limited to the primary effects of the injury; often, after an attempt has been made to save the parts, the surgeon is chagrined to find that all his efforts have been unavailing, that the patient is gradually worn out by hectic irritation and profuse discharge, and that amputation, now performed as a dernier resort, hardly holds out a single prospect of cure. A guarded prognosis, then, is becoming in every case of complicated dislocation, however apparently insignificant.

Treatment.—Much of our success in these accidents will depend upon the promptness and efficiency of our treatment, or the manner in which the parts are managed during and after the reduction, which should always be effected as speedily as possible, and with as much care and gentleness as the case will admit of, the patient being fully anaesthetized. If any wound exist, the edges must be brought accurately together with adhesive plaster, aided, if necessary, by suture, and coated with collodion to exclude the air. Or, Mr. Lister's antiseptic dressing, described elsewhere, may be used; for, although there is every reason to believe that its efficacy has been much exaggerated, it, nevertheless, possesses a certain value as a " protective," and is, therefore, deserving of a fair trial, the more especially as it is not likely, if properly applied, to do any harm.

Any loose splinters of bone that may be present in these accidents should at once be removed, while any that are sufficiently adherent to render it probable that, if left, they will reunite should not be interfered with. The fingers and forceps are the best instruments for performing the operation. If the end of the bone protrude at the wound, it must be promptly restored to its natural position, any dirt that may cover it having previously been picked away, or removed with the syringe. If it be girt by the integument, so as to render the reduction impracticable, a circumstance, however, which must be

extremely rare, the opening must be carefully enlarged with the probe-pointed bistoury; and a similar practice should be followed when the wound is too small to admit of the easy extraction of loose fragments. If the end of the bone is very sharp, angular, or denuded of periosteum, it should be cut off with the saw or pliers, but such a step should only be taken after the most thorough conviction of its imperative necessity; for the same rule applies here as in the soft parts, to save all we can, and sacrifice nothing improperly. I can hardly conceive of a case where it would be necessary to remove the end of a dislocated bone simply because it protrudes at a wound. If the patient is completely relaxed by anæsthesia, extension and counterextension, with judicious coaptative pressure, could not fail to effect restoration, even when the bone is very tightly girt.

When ordinary means fail to overcome the resistance of the muscles, tenotomy may be employed, as originally practised by Mr. William Hey, of Leeds, in a case of compound dislocation of the ankle, and since repeated upon other joints by Dieffenbach and other surgeons.

Finally, when the luxation is complicated with fracture, the rule is to reduce the former before the latter is permanently set, for the reason that, if the restoration of the joint be postponed until the broken bone is repaired, it will often be impossible to effect it. Besides, the union might be destroyed under the effort. Under such circumstances, the reduction of the luxation is always greatly facilitated by putting up the fracture firmly in splints, as a longer and better average is thus secured.

The reduction having been effected, the joint and corresponding limb are to be enveloped in a bandage—that of Scultetus being passed around the wounded part—and placed securely in splints, or, what is preferable, in a wire case, or wooden box, in order to keep it perfectly at rest, and in as easy a position as possible. Pain and inflammation are relieved by the usual remedies; and it is here that anodynes will be likely to display their happiest effects, both in allaying suffering and in preventing serious constitutional disturbance. Antiphlogistics must be employed warily, with due reference to the effects of shock, long confinement, and copious drainage. In a word, the patient must not be purged and bled simply because he has a compound dislocation; on the contrary, such measures, if used at all, must be used with the greatest possible caution. The diet must be rigidly adapted to the exigencies of the case; as in all other severe injuries, it should be nutritious rather than otherwise, and instances will not unfrequently arise where it should be decidedly so from the very commencement of the treatment. The enfeebled patient will often be immensely benefited by the addition of milk punch, whiskey, ale, or porter, especially if he is accustomed to the habitual use of any of these articles. Quinine and iron will materially aid recovery in the event of suppuration, erysipelas, or pyæmia.

The affected parts are handled as little and as gently as possible; all officious interference is refrained from; the secretions are removed from time to time with the sponge, and fetor is allayed with chloralum or permanganate of potassium. In case of wound, or much discharge, the limb should be surrounded with bran, for the threefold purpose of maintaining equable pressure, absorbing the secretions, and affording a comfortable bed for the parts to rest upon, with the additional advantage, in hot weather, of preventing the formation of maggots.

Concerning the propriety of amputation, the same general rules are applicable as in complicated fractures, a subject duly discussed under that head. The following summary, however, respecting the operation, will not be out of place here. The reasons for immediate amputation are, first, the excessive contusion and laceration of the soft parts; secondly, the rupture of the principal artery or nerve of the limb, attended with other serious injury; thirdly, an extremely shattered state of the bones; fourthly, free exposure of a large joint; and, lastly, the advanced age, depraved habits, or ill health of the patient. Secondary amputation may be required, when, after an attempt has been made to save the limb, gangrene has taken place, or life is assailed by exhausting suppuration, consequent upon extensive disease of the soft parts, the joint, or bones, or of all these structures together. Very great or irremediable deformity of the limb, standing in the way of its usefulness, is also a just cause for amputation.

Instead of amputation, in some of the above cases, excision may occasionally be advantageously employed, either primarily or secondarily. The primary operation is particularly indicated in dislocations complicated with a shattered and comminuted condition of the head of the displaced bone, and has been so often performed beneficially that it may now be regarded as one of the established proceedings in surgery. Its greatest success has been obtained in compound luxations of the shoulder-joint. Even when there is no fracture of the head of the dislocated bone, but simply extensive laceration of the liga-

ments, completely detaching the parts from each other, it is questionable whether, in many cases, excision would not be the more expedient practice.

Secondary resection may be employed in caries, or caries and necrosis, of the ends of the bone, coming on after a fruitless attempt to save the parts.

4. CHRONIC, OLD, OR NEGLECTED DISLOCATIONS.

The subject of chronic, old, or neglected luxations has not received the attention which its importance merits. The morbid anatomy of these accidents is still imperfectly understood, no connected body of facts illustrative of it having yet been published, and it is to be feared that their treatment is seldom guided by sound scientific principles. They constitute a class of cases which almost every surgeon approaches with doubts and misgivings, being anxious to do something for the patient's relief, and yet afraid the interference should produce serious, if not irreparable, mischief. I candidly confess that I have always shared these feelings, and that I have never had charge of an old or neglected dislocation without a strong secret wish that it had fallen into other hands, such have usually been my disappointment and the anxiety attendant upon my efforts at reduction. The risk of rupturing an important vessel, perhaps the main artery of a limb, of breaking a bone, or of exciting extensive suppuration in the parts around the affected joint, with the more remote chance of inducing pyemia, is well calculated to cause one to hesitate before he enters upon an enterprise so fraught with unpleasant consequences.

The blood that is effused in dislocations, unless unusually abundant, is generally very soon absorbed, as after other accidents involving subcutaneous hemorrhage. On this account it is very seldom that an opportunity is afforded of meeting with any in chronic cases; it is only now and then that a small clot or stratum, decolorized, and partially organized, is seen, and even this is almost always eventually carried off. The inflammation consequent upon the lesion is constantly followed by a deposit of plastic matter, both in and around the joint, filling up the socket of the bone, and infiltrating the connective tissue, muscles, and other structures in the neighborhood. More or less of this substance is also effused around the displaced head, where it is gradually organized, and at length converted into an adventitious capsule, of a pale-grayish aspect, and of a dense, fibroid texture, not unlike the original capsule, with which it generally communicates by one or more openings, and which, by degrees, becomes wasted and attenuated from want of use. The muscles, in great measure deprived of their functions, are transformed into pale, rigid, contracted bands, which, in time, often undergo the fatty degeneration. The periosteum, near the joint, is usually somewhat thickened, and occasionally even studded with os-

Fig. 641.

Old Dislocation of the Hip, a new Acetabulum being formed, while the Original one is but little Changed.

seous stalactites. The cartilage of the affected socket is generally partially absorbed, or more or less changed in its appearance, texture, and consistence, while that which invests the head of the bone exhibits a rough, scabrous aspect, being thickened at one point and atrophied at another, the osseous substance itself often becoming hard and sometimes even eburnized. Few opportunities have occurred of observing the condition of the vessels and nerves in ancient dislocations; in the cases in which this has been noticed, the former were found to be preternaturally flexuous, to accommodate themselves to the displaced bone, and the latter somewhat attenuated, but otherwise sound.

In those cases in which the displaced head enjoys a good deal of freedom, it generally forms for itself a sort of socket, as in fig. 641, most commonly in a neighboring bone, but sometimes in the substance of a muscle, or partly in the one, and partly in the other. This socket, however, although it may admit of considerable motion, is a very imperfect type of the original, as is also the new ligamentous tissue by which it is surrounded.

In addition to the changes now described, relating exclusively to the articular struc-

tures and to the parts immediately around, changes which are usually the more conspicu-
ous in proportion to the duration of the dislocation, it will be found that the whole limb
below the seat of the injury, and sometimes even for some distance above it, has a
shrunken and withered appearance, its muscles being thin, flabby, and wasted, and its tem-
perature materially diminished.   In many cases it is affected with rheumatic or neuralgic
pains, subject to aggravation with every change of the weather and with every disorder of
the general health.   The motion of the new joint is necessarily much restricted, and is
often performed with a peculiar grating noise and sensation, caused by the roughened state
of the contiguous surfaces, and the entire absence of synovial fluid.   When all motion is
lost, the joint gradually undergoes complete bony ankylosis.

Is it possible for the head of a bone, long dislocated, to undergo such an amount of
absorption as to give rise, when restored to its proper place, to shortening of the affected
limb?   I should unhesitatingly answer this question affirmatively, with the proviso, how-
ever, that the corresponding articular cavity retains its natural shape and depth.   In lux-
ation of the head of the femur, for example, the shortening of the thigh might, from this
cause, under peculiar circumstances, probably be from half an inch to eight, nine, or even
ten lines.   In discussing this question, it should be remembered that there is occasionally,
if indeed not frequently, a natural disparity in the length of the two limbs, both upper
and lower, amounting, it may be, to nearly one inch.

It has long been a question with surgeons at what period after the occurrence of a dis-
location it should be considered as impracticable to effect reduction, and the question, as
might have been expected, has been differently answered by different observers, and by
the same observers for different joints.   Thus, Sir Astley Cooper, who has always been
regarded as a leading authority upon the subject, thought that three months for the shoul-
der, and eight weeks for the hip, might be set down as the limit, beyond which any efforts
of this kind, except in persons of very lax fibre or advanced age, would be highly impru-
dent; an opinion which accords so well with general experience, as, in my judgment, to
entitle it to be considered as a law.   It cannot be denied that this law has exceptions,
but this only serves the more fully to establish its validity.   Thus, in relation to at least
one of the joints in question, that of the shoulder, a considerable number of cases have
been reported of reduction at from four to seven months after the receipt of the injury.
Indeed, Dr. Nathan Smith, of New Haven, met with one in which he succeeded com-
pletely nearly one year after the accident.   Examples of reduction of dislocations of the
hip-joint from three to six months' standing have also occurred, although it will be found,
upon careful inquiry, that their number is exceedingly small.

For the ginglymoid articulations the period is still more limited, although, in this
respect, it varies a good deal among themselves.   In the elbow-joint, the best type of the
ginglymoid class, I have found, in a very considerable number of cases, that any attempts
at reduction, however perseveringly or judiciously continued, generally prove completely
abortive after the third week.   The differences in the reducibility of dislocations of dif-
ferent articulations are altogether due to peculiarities of structure and to the amount of
inflammation consequent upon the injury.   The surfaces of the orbicular joints are com-
paratively smooth and simple, and their displacements are seldom followed by much inflam-
mation; the reverse in both particulars being true in regard to the ginglymoid joints.

Evidently, then, every luxation must rest, so to speak, upon its own merits, so far as
the question of its restoration is concerned; for, as just stated, while one joint becomes
irreducible in a fortnight or a month, another, differently constructed, may remain redu-
cible eight weeks, or even a much longer period.   A far better rule by which to decide
this question is to judge by the extent of motion of the affected bones, the previous attempts
at replacement, and the degree of inflammation consequent upon the injury.   If the joint
is very stiff and tender, if the luxated head has contracted firm adhesions, involving, per-
haps, a large artery, or some other important structure, and if, in addition to this, there
is reason to believe that the socket is filled up with new matter, any effort at reduction
would not only prove abortive, but might be followed by very serious accidents, jeopard-
ing limb and life.   Cases in which severe injury and even death were the consequences
of long-continued and violent attempts at reduction have happened to surgeons of great
experience and eminence, and should serve as warnings against the employment of undue
force where the prospect of success is at all doubtful.

The conduct to be observed in the reduction of chronic dislocations resolves itself into a
few simple rules.   In the first place, it is necessary, as an important preliminary, to pre-
pare the part, as well as the constitution, for the operation, by the systematic movement
of the joint, and by light diet and purgatives, aided, if the person is at all strong and ple-

thorie, by at least one large bleeding. The object of this depletion is not so much to weaken the muscles as to lessen the risk of severe inflammation and the formation of abscesses. The motion of the joint is intended to break up any abnormal adhesions that the bone may have contracted with the surrounding tissues, and should be conducted with great care and gentleness, the corresponding limb being carried about in different directions, flexed, extended, depressed, elevated, adducted, abducted, rotated, and circumducted; the operation should not be performed, at first, oftener than once a day, but by degrees it may be repeated every twelve hours, and it should be steadily continued for at least a fortnight, free use being made all along of evaporating and sorbefacient lotions, with minute doses of mercury, to promote the absorption of effused plasma. Continuous extension, as a preliminary step to more strenuous efforts for promoting the reduction of chronic dislocations, has lately been recommended, and is deserving of consideration, especially in the more simple forms of such accidents.

This preliminary treatment having been attended to, and the patient being thoroughly anæsthetized, the extension and counterextension are conducted in the usual manner, only with more care and patience, and with an additional number of assistants. The object is not, as in recent luxations, to fatigue the muscles, but to extend and stretch their fibres, shortened, hard, and tense from long-continued disease and inflammatory irritation. In no event should the surgeon employ violent or forcible measures, because such a procedure would be sure not only to increase the resistance, and, as a necessary result, the difficulties of the reduction, but be very likely to cause dangerous laceration of the soft parts, and secondary mischief. If the operation fail, it must not be too soon repeated, and in the mean time the suffering joint must be well supported and fomented. The rupture of an important artery, as, for examp'e, the axillary in dislocation of the shoulder, will be denoted by a rapid effusion of blood into the connecting tissues, discoloration of the integument, and cessation of pulsation in the distal portion of the limb. The proper remedy, in such an event, is immediate ligation of the affected vessel, and the avoidance, of course, of further interference. Should fracture occur, the operation must also at once be suspended, and the case treated upon general principles.

Dr. H. G. Davis, of New York, a few years ago, called attention to the value of continuous elastic extension, by means of India-rubber bands, in the treatment of chronic luxations, and he asserts that he has met, in several cases of this kind, with remarkable success. I am not sure that others have been equally fortunate. Dieffenbach, of Berlin, many years ago, proposed, as a measure of overcoming the resistance, under such circumstances, the subcutaneous division of the muscles concerned in opposing the restoration of the bone, and such an operation has repeatedly been performed, although rarely with the advantages that had been anticipated. I have myself occasionally employed it, but never with any decided benefit. The great objection to the procedure is the danger of wounding important structures, especially large vessels and nerves, which are very often greatly displaced, and which, if injured, might occasion serious consequences. No one, therefore, should undertake such an operation unless he has the clearest possible conceptions of the anatomy of the parts, and is fully prepared to meet any emergency that his knife may produce.

When the head of a displaced bone is immovably fixed in its new relations, and the corresponding limb is thereby rendered completely useless, an attempt should be made by the subcutaneous division of its neck to form an artificial joint. If the operation fail, the only thing that remains to be done is excision of the head, a procedure indispensably necessary when the bone presses upon large nerves, as, for example, in certain forms of luxation of the shoulder-joint.

5. CONGENITAL DISLOCATIONS.

There are certain dislocations which exist at birth, and which are, therefore, denominated congenital. Their occasional occurrence, recognized at an early period of the profession, has been satisfactorily established by a number of modern observers, especially by Chaussier, Paletta, Dupuytren, Breschet, Pravaz, R. W. Smith, Guérin, and Carnochan.

Different joints are liable to this variety of luxation, but its occurrence is by far most common in those of the hip, wrist, and shoulder. The lesion, although generally single, is sometimes double, existing simultaneously in the two opposite articulations. Occasionally it occurs in different joints in the same subject, as, for instance, in the shoulder and wrist, or in one of these joints and in that of the hip. Both sexes are liable to it, but by no

means in an equal degree, observation having shown that females suffer much more frequently than males. Instances are recorded in which the affection appeared in a number of successive generations, and also in several members of the same family.

The *causes* of congenital dislocations have excited much attention, as well as a great deal of controversy, without eliciting any positive results. The various theories that have been advanced in explanation of this vexed subject may be arranged under the following heads:—1st, external violence inflicted upon the fœtus; 2dly, disease of the articulations; 3dly, arrest of development.

1st. There can be no doubt that undue force exerted upon the fœtus, whether from without, as when the mother receives a fall or blow upon the abdomen, or from inordinate contraction of the uterus, is capable of inducing partial dislocation of the joints, or, at all events, such a state of the articulating surfaces as to predispose them strongly to its occurrence. It is well ascertained that external violence is capable of producing fractures of the fœtal bones; I have myself met with several remarkable examples of this kind, and Chaussier has recorded a case in which this lesion coexisted with congenital luxation of the hip and shoulder joints. It is extremely probable that a deficiency of the amniotic liquor may predispose to this occurrence, by enabling the womb to exert its contractile force more readily and fully upon the fœtus, thus forcing the articulating surfaces away from each other at a time when they are too imperfectly developed to resist such pressure, especially if frequently repeated. A theory of the formation of clubfoot, which is probably nothing originally but a partial displacement of the tarsal joints, has been founded upon this supposed contractile power of the uterus, and of its injurious influence upon the fœtus. Finally, it is not improbable that what is termed a congenital luxation may be occasionally produced by violence inflicted upon certain joints during delivery, in rude and forcible attempts to bring away the extremities.

2d. The second theory rests upon the idea that the lesion depends upon congenital disease of the joints, inducing relaxation of the ligaments, and so favoring the action of the muscles in separating the articular surfaces, and interfering with their development. Children in the womb are, as is well known, liable to numerous affections, some of them of a highly inflammatory character, terminating at one time in death, and at another in serious and irremediable deformity. Of these affections, synovitis is one, and it is probable that it generally has a gouty, rheumatic, or syphilitic origin.

3d. The theory of an arrest of development has many advocates, both in regard to the origin of this and other affections; but what do we know of it? Certainly nothing beyond the fact that it is expressive of the imperfect growth of a part, and of the concomitant deformity; it affords no clue whatever to the nature of the causes, either remote or proximate, that induced it. The fault may exist in the germ, or it may be superadded to it after conception, in consequence of some intrinsic defect, or as a result of the operation of causes acting through the mother.

The *pathological* changes accompanying this lesion are numerous and diversified. In the first place, the dislocated articular extremities are generally deprived, in part, if not entirely, of their natural shape and structure; they are rounded off, divested of synovial membrane and cartilage, atrophied, and otherwise altered. The deepest cavity, as, for instance, the cotyloid, often completely disappears, not by being filled up with plastic matter, as in traumatic luxation, but by the absorption of its component elements. Very frequently the displaced bone forms a new socket, generally superficial, but quite sufficient for the amount of motion to which it is restricted. The ligaments are elongated and relaxed, thin, ribbon-shaped, partially wasted, or completely destroyed; occasionally, however, instead of being stretched and attenuated, they are very short, tense, and strong, obviously from interstitial deposits. The surrounding muscles are either pale, wasted, and partially transformed into fatty matter, or they are unnaturally large and stout, from the increased exercise devolved upon them by the dislocated bone.

The *symptoms* of congenital dislocation are characteristic. The affection, manifesting itself in various kinds of deformity, is noticed at, or soon after, birth, having commenced without any apparent violence; it is unattended with pain, or, if pain is present, it is much less than in the traumatic form of dislocation; the swelling also is inconsiderable, if, indeed, there is any at all; the head of the bone can be felt in its abnormal position, and the portion of the limb connected with it is generally singularly distorted, being changed in its axis, flexed, extended, or twisted. Motion is either much impeded, or too free; the affected member is commonly somewhat shortened, and more or less attenuated, from the wasted condition of its muscles. By extension and counterextension the displaced surfaces may generally be easily restored to their natural position but the moment

they are discontinued they resume their former condition. This is practicable, however, only in the younger class of subjects; in old cases, reduction is always proportionately difficult, indeed, often impossible. The deformity invariably increases with age, and is sure to be followed by an arrest of growth of the surrounding structures.

The *prognosis* is altogether unfavorable, and this is particularly true of the lesion when it is of long standing, as when the person has attained the age of puberty or of manhood, when no plan of treatment that has yet been devised can be of any material, if, indeed, of the slightest, avail, owing to the impossibility of effecting accurate adjustment of the articular surfaces, in consequence of the organic changes which they have undergone. Even under the most propitious circumstances, as it respects age and preservation of structure, the difficulties of effecting a permanent cure will generally be extremely great, well calculated to exhaust the patience both of the subject and the surgeon. The prognosis should, therefore, always be very guarded.

Treatment.—From what has been stated, it is evident that the sooner the treatment of this lesion is commenced the more likely will it be to be successful, or, if not altogether successful, productive of amelioration. The two leading indications obviously are to effect reduction, and to prevent a recurrence of the displacement. No difficulty is generally experienced in fulfilling the former, especially in very young and tender subjects; it is the latter that causes all the trouble, annoys the patient, and frets the surgeon. Various kinds of apparatus, much of it of a very complicated and expensive character, have been devised for retaining the parts in contact after their restoration; but it admits of doubt whether most of it could not advantageously be replaced by more simple means, such as ordinary splints, wire cases, and adhesive strips and rollers, which might be so applied as, in most cases, to answer the purpose most perfectly. Permanent extension and counterextension will be required when there is retraction of the dislocated bone. Long confinement, however, should always, if possible, be avoided, as it is of paramount importance to preserve the general health. The principal local remedies, worthy of attention, are the cold douche and friction with ammoniated and other liniments, together with direct support. If the patient is feeble and anemic, benefit will accrue from the use of tonics, as iron and quinine, a nutritious diet, and exercise in the open air.

When the reduction of these dislocations is opposed by the permanent contraction of the muscles, the only way to overcome the obstacle is tenotomy. The case should afterwards be treated upon the same principles as in clubfoot.

<center>SECT. XII.—DISLOCATIONS OF PARTICULAR JOINTS.</center>

<center>1. HEAD AND TRUNK.</center>

<center>DISLOCATIONS OF THE HYOID BONE.</center>

The possibility of a dislocation of this bone is fully attested by a number of well-authenticated examples. In 1848, Dr. Ripley, of South Carolina, read a paper upon the subject before the Medical Society of Paris, in which he described such an accident as having occurred in his own person; and Dr. Gibb, of London, has met with not less than four cases of it, all in the male sex. In one of these there was an occasional displacement of the left horn of the hyoid bone, the patient perceiving a sudden click in that part of the neck, and a sensation as if something were sticking in his throat. He at length died of phthisis, when it was ascertained that the thyro-hyoid articulation contained, besides a considerable quantity of clear fluid, a large sesamoid bone, the whole arrangement being such as to admit of an extraordinary amount of motion.

The reduction is effected by throwing the head backwards as far as possible, so as to put the muscles of the neck completely on the stretch, and then relaxing the lower jaw, at the same time that gentle pressure is made upon the displaced part. The bone, in the case of Dr. Ripley, always returned with a click.

<center>DISLOCATIONS OF THE JAW.</center>

The connection between the lower maxillary and temporal bones is established by a hinge-joint, each condyle of the former moving upon an interarticular cartilage, and being held in place by two ligaments. Luxation, therefore, can occur only in one direction, that is, forwards and downwards, the condyle slipping off the articular eminence of the

temporal bone into the zygomatic fossa, as in fig. 642. The coronoid process lies immediately below the malar bone, the temporal muscle and the ligaments of the jaw are unnaturally tense, and the interarticular fibro-cartilage is partially dragged from

Fig. 642.
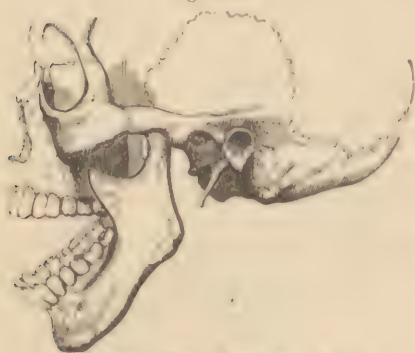
Double Dislocation of the Lower Jaw.

its position, but retains its attachment to the condyle. The displacement is usually double, affecting both sides simultaneously, and is commonly produced by some sudden, spasmodic contraction of the muscles in yawning, laughing, vomiting, or convulsions. Dorsey has recorded the case of a woman who luxated her jaw in the act of scolding her husband. The accident has sometimes happened in an attempt to extract a tooth, to bite a large apple, or to crack a nut. Occasionally it arises from a blow, fall, or kick upon the chin, the mouth being widely opened at the moment, and the condyle advanced upon the articular eminence. In 1861 I saw a woman, twenty-nine years of age, a patient of Dr. Emile Fischer, who dislocated her jaw on both sides in an attempt, during an attack of delirium, to pull her tongue out of the mouth. Dr. H. C. McCarthy has communicated to me the particulars of the case of a woman, aged thirty-two years, in which it was occasioned in an epileptic fit. Dr. Guignier met with an instance consequent upon a laryngoscopic inspection.

Fig. 643.

Dislocation of the Lower Jaw.

More frequent in women than in men, and in middle-aged and delicate subjects than in the old and robust, it is extremely rare in young children, owing to the peculiar conformation of the body and branches of the jaw rendering the occurrence one of great difficulty. A case has been reported by Chassaignac in which, in a fall from a great height on the chin, one of the condyles of the jaw was driven through the temporal fossa into the skull.

The *symptoms* are generally characteristic. The mouth, as exhibited in fig. 643, is widely opened, and cannot possibly be closed; the chin is unusually prominent, and the lower line of teeth projects considerably beyond the upper; the saliva, increased in quantity, dribbles off involuntarily; deglutition and articulation are performed with great difficulty; the cheeks and temples are flattened, and, as it were, elongated; the coronoid process is easily distinguishable in the zygomatic fossa, especially if examined through the mouth; and, instead of the natural prominence formed by the condyle immediately in front of the ear, there is a distinct vacuity capable of receiving the end of the finger, although not without some effort, owing to the great tension of the integument. When the displacement has existed for some time, the symptoms will be less marked, but still sufficiently characteristic to prevent mistake, provided the surgeon informs himself fully of the history of the case and of the actual condition of the jaw and mouth. Notwithstanding this, a very ridiculous error has occasionally been committed, as in an instance which came under my observation in a middle-aged woman, who, in an attack of cholera, luxated the lower jaw, the accident being mistaken for tetanus. An error has occasionally been made after apoplexy attended with paralysis of the muscles of one side of the face.

When the luxation remains unreduced, the jaw, in time, partially regains its motion, the dental arches approaching each other, so that, eventually, the patient may even be able to masticate his food; speech and deglutition also improve; the saliva ceases to dribble; and much of the disagreeable deformity disappears.

The patient, during the *reduction*, may sit upon the floor or upon a low stool, his head being well supported by an assistant. The surgeon, standing in front, introduces his thumbs, carefully defended with the end of a napkin, into the mouth, as far back as pos-

sible upon the large grinders, while he places the fingers of each hand under the chin and base of the jaw. Using his thumbs as fulcrums, he forcibly depresses the back part of the jaw, to disengage the condyles from the zygomatic fossæ, and at the same moment elevates the chin with his fingers, thus converting the bone into a lever of the first kind. Or, instead of this, the thumbs being placed as before, the surgeon grasps the angles of the jaw with his fingers, when, the mouth being well opened, the slightest downward pressure will be sufficient to disengage the condyles, and so enable the temporal and masseter muscles to effect the reduction. Restoration is generally indicated by a loud snap, and the instant it is about to occur the surgeon quickly removes his thumbs from the teeth, lest, in the act of closure of the jaw, they be seriously injured by the suddenness and violence of the contraction of the muscles.

The reduction is always greatly facilitated by the use of anæsthesia, which, while it completely relaxes the muscles, obviates the necessity of removing the thumbs from the jaw as the bone is sliding noiselessly into its place.

A very simple and efficient method of reducing dislocations of the lower jaw was originally suggested by Nélaton. The patient being seated upon a chair, and the mouth widely opened, the surgeon, standing behind him, plants his thumbs upon the upper part of the nape of the neck, and then with the fingers pushes the jaw forwards by pressing against the prominence formed on each side of the cheek by the point of the coronoid process. A small amount of force generally suffices to effect the object, the condyles returning with a distinct snap. When the resistance is unusually great, the head may be supported by an assistant, or a band may be passed around it, in which the operator engages his fingers, while the thumbs, resting upon the cheeks, are made to bear upon the coronoid process from above downwards, and from before backwards.

The older surgeons were in the habit of reducing luxations of the lower jaw by placing between the molar teeth two pieces of cork or wood, which they used as fulcrums to depress the back part of the bone, while they raised the chin by means of a bandage. Another method, occasionally employed by them, consisted in pressing a stick against the lower grinders, so as to keep the jaws separated until the irritated and contracted muscles, overcome by fatigue, allowed the condyles to glide into their natural situation. In obstinate cases, I have occasionally accomplished the object after a failure of the ordinary methods, by reducing the dislocation, first, on one side, and then on the other, the success being evidently due to the removal of the tension of the muscles concerned in keeping the bone in its constrained position.

In unilateral displacement of this bone, the chin is thrown towards the opposite side; the parallelism of the front teeth is lost; the mouth is open, but less widely than in the double luxation; speech and deglutition are somewhat impeded; and the depression in front of the ear is perceptible only on the injured side. The reduction is effected upon the same principle as in the other form of the accident, with the difference that only one thumb is used. Tartra met with a case of unilateral dislocation of the jaw in a child only fifteen months old.

After both of these luxations, but especially the bilateral, the patient should for some time avoid opening his mouth, as the accident is extremely liable to recur from very slight causes. The safest plan, therefore, is to support the jaw with an appropriate bandage, as that, for example, used in fracture. During the first few weeks the nourishment should consist exclusively of slops and of other articles that do not require mastication.

When the dislocation is complicated with fracture of the jaw, the difficulty which is sometimes experienced in keeping the parts in place may generally be easily remedied by means of a mould of sheet lead. In the case of an elderly gentleman in whom this coincidence existed, and whom I attended along with Dr. W. Macpherson, this mode of dressing answered the object most admirably.

In neglected cases of this dislocation the reduction will generally be found to be very difficult even as early as the end of the third or fourth week. Occasionally, however, it will succeed after a much longer interval. Thus, Morley had a case at the thirty-fifth day; Spat at the fifty-eighth; Donovan at the ninety-eighth; Nélaton at the one hundred and fourteenth; Michon and Gosselin at the one hundred and thirtieth day, and Pollock one at the end of the fourth month. When the ordinary means fail, instead of abandoning the patient to his fate, the efforts at reduction should be aided by the subcutaneous section of the external pterygoid, masseter, and temporal muscles.

There is a rare species of displacement of the lower jaw, originally described by Sir

Astley Cooper under the name of *subluxation*, which, apparently, depends upon an unusual laxity of the ligaments, permitting the condyle to slip off the interarticular cartilage. It is most common in weak, delicate females, and is characterized by inability to close the mouth, with more or less pain, and a feeling of tension on the injured side. If the bone do not return of its own accord, as it generally will, replacement may easily be effected by drawing the jaw slightly forwards and downwards, so as to afford the condyle an opportunity of reinstating itself upon the interarticular cartilage.

A curious condition of the temporo-maxillary joints is occasionally met with, chiefly in young, feeble, anemic subjects, which, on account of the peculiar crackling, creaking, or snapping noise so constantly attendant upon it, is often a source of great annoyance and even mortification. Its immediate cause is a relaxed condition of the ligaments, which allows the condyles to mount upon the articular eminences when the jaw is depressed, and of their slipping back suddenly when it is elevated. There is generally a deficiency of synovial fluid, and the condyles not unfrequently form unsightly prominences under the skin, especially in thin, emaciated persons. The most suitable remedies are tonics, as iron and quinine, the cold shower-bath, electricity, exercise in the open air, and the application of a series of little blisters over the affected part. The jaw should be carefully protected during yawning.

A *congenital* dislocation of the lower jaw has been observed in a few cases. Mr. Robert W. Smith having been the first to describe such an accident, of which he has given, with great minuteness, the results of the dissection. The patient, an idiot from infancy, died at the age of thirty-eight. The luxation existed on the right side, which was remarkably deformed, having a singularly hollow appearance, which strikingly contrasted with that of the sound one, which was unusually full and plump. The extremity of the finger could readily be pressed between the posterior margin of the jaw and the external auditory canal, owing, as was found on dissection, to the absence of the condyle of the bone, which was, in fact, greatly atrophied nearly as far forward as the symphysis. There was no interarticular cartilage, or distinct capsular ligament; and both the masseter, pterygoid, and temporal muscles were much wasted. The temporal, malar, superior maxillary, and sphenoid bones were imperfectly developed, and the glenoid cavity existed merely in a rudimentary state.

DISLOCATIONS OF THE CLAVICLE.

Dislocation of the clavicle, compared with fracture of this bone, is extremely uncommon, there being probably fifty cases of the latter to one of the former. The cause of this remarkable difference is to be found in the exposed situation of the bone, and the great shortness and strength of its ligaments, which render it much more liable to yield in its continuity than at its articulations with the sternum and scapula. The displacement may occur at either joint, and several instances are recorded in which both were simultaneously affected.

1. The *sternal extremity* may be dislocated forwards, backwards, and upwards, the relative frequency of the accident being in the order here stated. Luxation downwards is rendered impossible by the resistance offered by the cartilage of the first rib.

Dislocation *forwards* is generally produced by injury inflicted upon the top of the shoulder, or by falls upon the elbow when the arm is separated from the trunk. The clavicle, being thus impelled violently forwards and inwards, completely ruptures the sterno-clavicular ligaments, and present itself, along with the interarticular cartilage, in front of the upper part of the sternum. The sterno-cleido-mastoid muscle is pushed down, and some of its inner fibres are occasionally lacerated, particularly when they take their origin unusually near the joint.

The signs are, a hard, circumscribed, incompressible tumor at the upper and anterior part of the sternum, a vacuity at the natural situation of the joint, unusual prominence of the inner portion of the sterno-cleido-mastoid muscle, depression of the shoulder, and inclination of the head towards the affected side. The most reliable evidence, however, of the nature of the accident, is derived from tracing the outline of the bone with the finger of one hand, while the shoulder is moved by grasping the elbow with the other, and by recollecting that in dislocation the bone retains its normal length, while in fracture it is materially shortened. The head of the clavicle overlaps the sternum, and is always, as in fig. 644, directed downwards, so as to enable the examiner readily to distinguish the articular surface from which it has been removed.

The reduction is effected easily enough, but unfortunately it is retained with so much difficulty that, despite the best directed efforts of the surgeon, hardly an instance recovers without some degree of deformity. Many years ago I had a case of this kind under my charge, which, notwithstanding the most vigilant care and attention, was as bad, as it respected the cure, at the end of three months, as it was on the day it happened. Since then I have met with several similar examples. The articular cavity of the sternum is so shallow, and the ligaments unite with so much difficulty, that it is almost impossible to keep the parts in apposition sufficiently well or long to obtain complete consolidation. Fortunately, however, this occurrence does not materially affect the movements of the shoulder, for experience has shown that these are very soon, in great degree, reëstablished. It is a matter, therefore, simply of deformity, not of utility.

Fig. 644.

Dislocation of the Sternal End of the Clavicle.

To reduce this luxation, one hand is placed, shut, in the axilla, while the other grasping the elbow, pushes up the humerus against the clavicle and scapula. The shoulder is next carried upwards, outwards, and backwards, in a direction opposite to that of its displacement, and the forearm brought forwards across the chest, so that the thumb and fingers shall rest upon the sound collar-bone. If by this manœuvre the articular surfaces do not resume their natural relations, the reduction should be promoted by pressing the luxated head of the clavicle slightly upwards and backwards. A wedge-shaped pad, with the thick end upwards, being placed in the axilla, the limb is firmly secured to the side and front of the chest by the ordinary immovable fracture apparatus, a stout, square compress being applied directly over the sterno-clavicular articulation. The dressing must be frequently inspected, with a view to its readjustment, and be worn, with great constancy and regularity, for at least three months.

Dislocation backwards is generally produced in an indirect manner by injury applied to the shoulder impelling the scapula and the outer extremity of the clavicle forwards. It may also be caused by a severe blow upon the inner end of the bone, by the body being crushed between two resisting objects, and by violent traction upon the upper extremity when the trunk is firmly fixed and inclined backwards. The distinctive sign is that the head of the clavicle is forced backwards, and that it can be felt behind the summit of the sternum, sometimes below, at other times above, the level of that bone. A vacuity exists at the natural situation of the joint, the shoulder is directed somewhat forwards, the arm hangs uselessly by the side, and there is generally considerable dyspnœa, with cerebral congestion, and difficulty of deglutition, from the pressure of the luxated bone upon the trachea, cervical vessels, and œsophagus. The ligaments are completely ruptured, and the sterno-cleido-mastoid muscle is partially separated from its sternal attachments.

The reduction is effected upon the same principles as in the dislocation forwards, the fist being placed in the axilla and used as a fulcrum, while the shoulder is pushed upwards, outwards, and well backwards, and retained in this position by an appropriate apparatus, of which a figure-of-8 bandage, with a long, thick, square compress between the shoulders, is one of the best. Whatever means, however, be employed, it will be found extremely difficult to keep the articular surfaces in apposition and to prevent deformity. When the reduction is unusually obstinate, as it sometimes is when the head of the bone is firmly wedged in behind the sternum, the knee should be placed between the shoulders, the affected one of which should then be drawn forcibly backwards and outwards, the arm being at the same time extended nearly at a right angle with the trunk.

This variety of dislocation is sometimes produced by deformity of the spine, allowing the shoulder to sink gradually forwards so as to push the head of the bone from the sternum. In a case of this kind reported by Mr. Davie, of England, the clavicle compressed the œsophagus so severely as to cause great difficulty in swallowing, and danger to life by starvation. As reduction was impracticable, the trouble was remedied by sawing off the sternal end of the bone about one inch from the articulation. The patient speedily recovered, and lived six years after the operation.

Luxation upwards is so extremely rare that many of the most experienced surgeons formerly doubted the possibility of its occurrence. The cases, however, that have been reported by Macfarlane, Baraduc, Malgaigne, and others, fully establish its claims to the
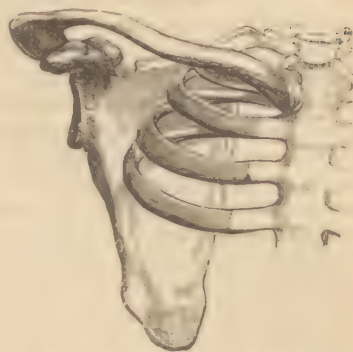
character of a distinct species. The accident generally results from violence inflicted upon the shoulder, as a blow or fall, driving the scapula downwards and inwards towards the chest, thus separating the bone from its connections, and forcing it upwards above the fourchette of the sternum. The symptoms are usually very characteristic. The bony tumor can be distinctly felt and seen in front of the trachea, where it is easily impressed by moving the corresponding arm; the shoulder, sunk forwards and downwards, approaches nearer to the median line than naturally; there is a remarkable interval between the clavicle and the cartilage of the first rib, amounting to from six to twelve lines; the sterno-cleido mastoid muscle is put upon the stretch; and there is a vacuity at the joint, as in the other forms of the accident. The reduction is very easily effected, simply by lifting the shoulder thoroughly away from the chest, at the same time that it is slightly elevated and inclined backwards, and pressure made directly upon the luxated head. Retention will be facilitated by placing a pad in the axilla, and supporting the elbow and forearm well with adhesive strips and bandages. The union is generally imperfect, but this does not materially weaken the functions of the limb.

2. The *acromio-clavicular* articulation is formed by the acromion process of the scapula and the outer extremity of the clavicle, by a species of arthrodia, the concave surface of the former being closely adapted to the convexity of the latter, and the union established by strong ligamentous bands. Admitting hardly of any motion, it can be dislocated only by external violence applied either directly to one or the other of the two bones, or indirectly through the arm and sternum. The accident is usually attended with severe contusion of the soft parts, and is seldom so thoroughly repaired as not to be followed by some degree of deformity, although the recovery of the motions of the limb is eventually sufficiently perfect for all useful purposes.

The scapular end of the clavicle may be thrown from its natural position in three different directions; upwards, above the acromion process, downwards and backwards, beneath this prominence, and downwards and forwards, under the coracoid process. Of these luxations, the first is by far the most frequent, both the others being extremely rare.

Fig. 645.

Dislocation of the Acromial End of the Clavicle.

In the dislocation *upwards*, the end of the clavicle, breaking away from its articular connections, is thrown up by the action of the trapezius muscle, or by the impelling force, so as to overlap the acromion process, as in fig. 645, and form a small, hard, round tumor immediately beneath the skin, which disappears upon raising the arm, but is reproduced the moment we let go our hold. The head is inclined towards the injured side, the limb hangs closely along the trunk, the shoulder looks as if it were somewhat flattened, and the patient is unable, without great pain and difficulty, to carry his hand to his mouth; in a word, the whole attitude of the body is nearly the same as in fracture of the clavicle. The accident is usually caused by a blow upon the shoulder, and the circumstance of the trunk being strongly impelled forwards promotes the luxation by increasing the strain. It may also be occasioned by a fall upon the elbow, and by a kick upon the acromion process. However induced, there is necessarily, in the complete form of the lesion, a rupture not only of the acromio-clavicular ligaments, but also of the ligaments connecting the clavicle with the coracoid process. In the incomplete luxation the latter always escape.

The clavicle will readily resume its natural position if the shoulders be pushed upwards and backwards, while the knee is interposed between them behind, as the patient sits upon a chair. To maintain it in this situation, the same apparatus and dressings must be used as in fracture of this bone, and in the sterno-clavicular luxations, already described. A thick pad, with the base directed upwards, is placed in the axilla, and the arm and forearm must be well secured to the chest. Direct pressure by means of a stout compress and piece of sheet lead should be made upon the acromio-clavicular junction, and confined by a broad strap extending round the corresponding elbow, and secured to the chest with buckles; or, if greater pressure be required, a Petit's tourniquet may be employed, as suggested by Laugier. In a case which I saw along with Professor W. H. Pancoast, in

an elderly gentleman, this plan answered admirably. Despite, however, of all the precaution, care, and skill of the surgeon, he will seldom be able to procure a good cure. I have seen cases of this description treated for months with the most determined effort to succeed, and yet at the end of this time it was impossible for the patient to move his arm without causing a relapse.

Dislocation *downwards*, appropriately named infraäcromial, is exceedingly uncommon, only a few cases of it having been reported. The fact is, although it was described by J. L. Petit, who believed it was more frequent than dislocation upwards, it has been almost entirely ignored by modern systematic writers. It has been alleged that the accident cannot happen without previous fracture of the coracoid process, a conjecture which has been satisfactorily disproved by experiments performed upon the dead subject.

The accident, in a few cases that have been carefully studied, has been the result of violence inflicted upon the shoulder, as a heavy blow, or a kick from a horse, attended with a rupture of the coraco-clavicular ligaments. The characteristic sign is the situation of the end of the clavicle beneath the acromion process, which is at the same time remarkably prominent, and somewhat nearer to the sternum than in the natural state. The shoulder is flattened, and the arm, applied close to the side, is incapable of voluntary motion. When the evidence is so distinct, error of diagnosis must be impossible. If any doubt, however, should arise, it may easily be dispelled by tracing the outline of the two bones as far forwards as their articulation; the finger, as it approaches this point, will at once detect the extraordinary prominence of the one, and the marked depression of the other, and so reveal the true nature of the accident.

The reduction is accomplished by pulling the shoulder outwards and backwards, while the knee rests against the dorsal portion of the spine, and the patient's elbow is carried across the chest, to afford greater relaxation to the muscles, and convert the humerus into a lever for acting more efficiently upon the acromion process. Retention is effected in the usual manner, with the additional precaution of preventing all motion of the inferior extremity of the scapula.

The dislocation *forwards and downwards*, beneath the coracoid process—the infra-coracoid form of the accident—is, like the preceding, very uncommon, a fall or blow upon the anterior surface of the shoulder being the cause by which it is ordinarily produced. The symptoms are characteristic. Besides the contusion and discoloration common to all such injuries, the acromion and coracoid processes are unusually prominent; the top of the scapula is strongly inclined downwards and forwards, and there is a marked depression in the natural situation of the clavicle, which, upon being traced with the finger, is found to be directed outwards and downwards, its extremity being actually lodged in the axilla. The arm may be moved in every direction, except upwards and inwards.

The reduction is easily effected. The chest being firmly fixed with a strong napkin, an assistant seizes the arm, and, converting it into a lever, uses it for pushing the scapula forcibly outwards and backwards, while the surgeon himself, grasping the clavicle, disengages it from its position beneath the coracoid process, and thus restores it to its natural situation. The retention is maintained by the usual apparatus.

Owing to the peculiar structure of the sterno-clavicular and acromio-clavicular joints, and the fact that their ligaments are always very badly ruptured in their dislocations, it is almost impossible to keep the parts in contact by any apparatus that can be used for the purpose. In view of this difficulty, I suggested, many years ago, the propriety of connecting the articular extremities with silver wire introduced subcutaneously, and allowed to remain, if not permanently, at all events, until firm reunion is established. I have never had occasion to perform the operation, but successful cases of it have been reported by the late Dr. Cooper, of San Francisco, and the late Dr. Hodgen, of St. Louis. Recently, several cases of these different forms of luxations of the clavicle have been successfully treated, among others one by Dr. Eastman, of Indianapolis, with the plaster jacket, applied in such a manner as to place the affected joint thoroughly at rest, and prevent thoracic respiration.

Double dislocation of this bone has been observed only in a few instances. One of these, reported by Porral, is said to have occurred under the care of Gerdy, in the St. Louis Hospital, at Paris. The accident was caused by a fall from a third-story window, upon the upper and back part of the shoulder. The symptoms were well marked, the acromial ends of the bone being luxated backwards and upwards, the sternal upwards and forwards. The treatment was by Desault's well-known, but now obsolete, apparatus, aided by large, graduated compresses over the affected joints. Under this dressing, the

outer extremity of the clavicle soon became firmly united, but the other continued obstinately displaced.

A similar case was reported by Morel-Lavellee, in 1859 ; and, in 1866, Dr. N. L. North, of Brooklyn, met with another, his patient being a lad, fourteen years of age, who, in a fall from a stool, was thrown forcibly backwards, receiving the whole weight of his body upon the posterior part of the left shoulder. The displacement was complete at both joints.

The collar-bone is occasionally dislocated as the result of a *congenital* vice, as in a case which I saw in a child three months old, otherwise perfectly healthy and well formed. The displacement may be double ; but in the instance under my care it was confined to the sterno-clavicular articulation, the clavicle projecting upwards and forwards in a very unseemly manner ; and, although the reduction could readily be effected, it was impossible to keep the parts in place by any contrivance that could be devised for the purpose.

DISLOCATIONS OF THE STERNUM.

Dislocations of the sternum are extremely rare, and must necessarily be the result of extraordinary violence. Hence, they are nearly always complicated with serious lesion of the soft parts, and fracture of the ribs, spine, clavicle, or even of the sternum itself. The accident has hitherto been noticed only between the first and second pieces, the latter of which was always thrown in front of the other, no instance having yet been witnessed in which the displacement occurred in the opposite direction. In 10 cases collected by Malgaigne the dislocation was occasioned either by direct violence, as a blow or severe pressure, or by a fall from a considerable height, in which the spine was bent forcibly forwards. Of these cases, 5 terminated fatally from other injuries. Of 13 cases collected by Professor Brinton, of this city, including 1 observed by himself, 7 died and 6 recovered. The immediate cause of death in 6 of the cases was fracture of the vertebral column. When the luxation is simple, no serious consequences are to be apprehended. The most reliable symptom is deformity, attended with pain, dyspnœa, and a creaking sound during respiration. The only accident with which it is liable to be confounded is fracture of the sternum. The reduction is not always practicable. When the overlapping is considerable, the best plan is to extend the patient's body over a few large bolsters and to push the second piece forcibly downwards and backwards.

A few cases have been recorded of dislocation of the ensiform cartilage from blows or falls upon the epigastrium. The accident is generally attended with pain in the stomach, dyspnœa, and obstinate vomiting. Reduction is effected by extension and pressure. In one instance an incision was made on one side of the depressed cartilage, through the peritoneum, and restoration accomplished by means of an elevator.

An example of congenital dislocation of the ensiform cartilage, caused by a fall during the fifth month of pregnancy, has been reported by Seger.

DISLOCATIONS OF THE SCAPULA.

Displacement of the scapula, apart from that of the acromio-clavicular articulation, may depend upon different causes. In general, it is produced by a relaxation of the fibres of the broad dorsal muscle, as it passes over the inferior angle of this bone. So far as my observation extends, the affection is most common in young girls, of a feeble, delicate organization, about the age of puberty. It is also occasionally met with in boys, either from natural weakness, or from the violent, habitual exertion incident to certain avocations. When the affection exists in its worst form, the relaxation of the muscle may be so great as to permit the lower angle of the scapula to project in a very unseemly manner. In some instances both sides suffer simultaneously, and then the deformity is, of course, materially increased. Aching pain and weakness of the corresponding limb are ordinary concomitants of the complaint.

Occasionally the broad dorsal muscle, in consequence of a fall or blow, is forcibly wrenched from its connections with the scapula, and slips down beneath the inferior angle of the bone, which then forms a remarkable prominence immediately under the skin. The accident is easily recognized by the history of the case, by the contused condition of the soft parts, and by the loss of function in the superior extremity.

When the displacement is caused by a weak and relaxed condition of the dorsal muscle, the most reliable remedies are chalybeate tonics, friction with stimulating lotions, elec-

tricity, the cold shower-bath, and exercise in the open air.   The arm should be supported in a sling, close to the side of the body, and the inferior angle of the scapula kept in place by means of a suitable pad secured around the trunk, or, what is better, the plaster jacket.   In the traumatic form of the affection leeches and saturnine applications will be required, and the limb should be well raised and carried backwards, so as to afford complete relaxation to the injured muscle.   Reattachment of the torn fibres should be aimed at by keeping the scapula perfectly at rest for a long time, otherwise redisplacement will be inevitable.   This occurrence, however, is of less importance than is generally supposed, as in time the parts, in great measure, if not completely, regain their original power.

Serious malposition of the scapula sometimes arises from paralysis of the rhomboid muscles, chiefly in young, anemic persons, of a scrofulous habit of body.   Sedentary occupation and constrained posture powerfully predispose to its occurrence.   Great deformity is apt to attend, the posterior border and inferior angle of the scapula being widely separated from the trunk, and standing out in bold relief.   The treatment should consist of tonics and of various local means calculated to restore the functions of the affected muscles. Ammoniated lotions with the addition of strychnia, blisters, and the cold shower-bath, will be particularly serviceable.

DISLOCATIONS OF THE SPINE.

The vertebræ are so firmly connected to each other, and, excepting those of the neck, admit of such limited motion, that any injury directed against them is much more liable to break than to luxate them.   Even in the cervical region, where the mobility is much greater than anywhere else among these bones, the accident is exceedingly uncommon, and it is fortunate that it is so, since it is almost always fatal, owing to the violence in-

Fig. 646.   Fig. 647.

Dislocation of the Spine between the Fourth and Fifth
Cervical Vertebræ. The Cord was torn, the Paralysis being
complete, and Death occurred in a few days.

Dislocation of the Spine seen laterally.

flicted upon the spinal cord, as shown in figs. 646 and 647, causing death not unfrequently in an instant, or, at furthest, within the first few days.   When the patient survives the more immediate effects of the dislocation, he is very apt to perish from inflammation of the spinal cord and its envelops, at a period varying from a few weeks to several months. Hence, whether the accident be considered with reference to its primary or secondary effects, the prognosis must be equally guarded, few persons, under any circumstances, recovering.   In a dislocation of the sixth and seventh vertebræ, under the charge, many years ago, of Dr. Willard Parker and myself, death occurred in less than forty hours. The patient, a young circus-rider, met with the accident while engaged in tumbling in the ring; it was instantly followed by paralysis of all the extremities, and he gradually fell into a state of unconsciousness, which continued until he expired.   The neck was stiff and painful, but there was no sign of displacement.   On dissection, the articulating processes and bodies of the sixth and seventh cervical vertebræ were found to be completely detached from each other on the right side, but on the left the processes were still slightly adherent, while the connection between the bodies of the bones was perfect, although in a high state of tension.   The two contiguous spinous processes were completely severed. There was no fracture.   The spinal cord was sensibly compressed by the partial rotation

of the seventh vertebra, and there was a slight effusion of blood in the spinal canal at the seat of the injury.

In another case, that of a large, heavy man, twenty-six years of age, who was admitted into the Jefferson Medical College Hospital in 1879, under Dr. S. W. Gross, on account of dislocation of the fourth and fifth cervical vertebræ, attended with fracture of the contiguous bones, produced by a fall from the top of a railway car, the most prominent symptom was complete paralysis of all the extremities, with severe pain at the seat of the injury, priapism, and retention of urine. The respiration was unaffected. He survived the accident nearly two months and a half, suffering greatly from pain all the while, and becoming gradually more and more emaciated. The bowels acted naturally, but the urine, which had at first to be drawn off with a catheter, at length began to dribble away, and so continued up to the time of death. Hyperæsthesia in a high degree was also present during the last five or six weeks. A post-mortem inspection revealed the existence of a large clot of blood at the seat of the injury, compressing the spinal cord, and reducing it to nearly one half of its natural diameter. There was hardly any displacement of the luxated bones.

The above cases afford a good type of the effects which usually follow dislocations of the vertebræ. When the lesion occurs above the origin of the phrenic nerve, death is often instantaneous from stoppage of the respiration; if seated farther down, the patient may live for some time, and eventually even recover, although such a contingency is an extremely remote one. The diagnosis is generally very obscure, and it is usually impossible to determine whether the accident is a dislocation or a fracture, or a combination of both, while the treatment must, of necessity, be altogether empirical. The principal symptoms are paralysis of the extremities, tympanites, obstinate constipation, and retention of urine, which soon becomes loaded with phosphates, causing inflammation and ulceration of the bladder. If the patient survive any length of time, severe bedsores are liable to form upon the nates and other parts of the body, thus greatly increasing his suffering.

The most common cause of dislocation of the spine is external injury, as a blow, fall, or sudden wrench. An instance has been reported by La Salle in which the fifth and sixth cervical vertebræ were severed by a violent muscular effort, the patient, a maniac, dying in thirty-six hours. Occasionally the displacement is the result of ulceration of the vertebræ or the partial destruction of the ligaments.

As it respects the *reduction* of these dislocations, it is impossible to prescribe any regular or methodical course of procedure. Most practitioners, dreading interference on account of the danger of sudden compression of the spinal cord, and the consequent destruction of the patient, are in favor of letting the parts alone, hoping, with judicious management, for gradual recovery. Such a plan, it seems to me, is both wise and proper, at least in most cases, especially in those in which it is impossible to determine the diagnosis, or where the symptoms, although well marked, are not at all urgent, the patient having a tolerably good use of every part of the body save the one immediately concerned in the mischief. Under such circumstances, time and a "masterly inactivity" will often accomplish more than the most skilful interference. But there are exceptions to every rule, and while most cases of this kind should not be meddled with, I would strongly advise an opposite course where, the symptoms being well marked, and the danger urgent, there is reason to believe that the patient will, if not relieved, speedily perish. In such an event any attempt to save him, however desperate, would be perfectly justifiable and proper. If we succeed, we obtain a victory; if we fail, we can but hasten an occurrence otherwise inevitable. A number of instances are upon record in which the reduction was performed successfully. Thus, Dr. James R. Wood safely restored, by manipulation, a partial dislocation of the cervical vertebræ in a child; and Dr. Ayres, of Brooklyn, happily succeeded in a case of complete luxation of these bones ten days after the accident. The patient, a tall, muscular man, thirty years of age, had been violently struck on the back of the neck, the

Fig. 648.

Bilateral Dislocation of the Fifth Cervical Vertebra.

anterior portion of which was found to be remarkably convex from the blow, bulging forwards, and lifting up the larynx, as seen in fig. 648. The head, as the man sat in his chair, was thrown backwards and permanently fixed, the face being turned upwards. The posterior part of the neck exhibited a sharp, sudden angle at the junction of the fifth and sixth cervical vertebræ, around which the integument lay in folds. It was difficult to reach the bottom of this angle, even with strong pressure of the fingers, and, of course, the regular line formed by the projecting spinous processes was abruptly lost. The patient complained of intense pain at this part, and swallowed and breathed with difficulty; but there was not the slightest paralysis or diminution of sensation. The reduction was effected by means of the hands of the surgeon and of two assistants, applied to the chin and occiput in such a manner as to draw the head, at first, directly backwards, then upwards, and finally forwards, counterextension being made with two folded sheets stretched obliquely across the shoulders. The system was completely relaxed by chloroform, and the bones were distinctly felt slipping into their natural situation. No unpleasant symptoms followed, and at the end of a week the man had the complete use of his head and neck.

A traumatic luxation of the *occipito-atloid* articulation occasionally occurs, and generally, if not invariably, proves promptly fatal. The accident, until recently, was regarded by most writers as impossible, on account of the firm connections and restricted motions between the two bones.

A slow species of displacement occasionally occurs in this joint in children and youths, from scrofulous disease of the body and articular surfaces of the atlas, or of this bone and of some of the other vertebræ. Several examples of it have come under my personal observation, and the subject has been ably discussed by Schupke and other German writers. The severe local suffering which it produces is best allayed by rest and recumbency, leeches, blisters, and issues, especially those made with the actual cautery, while the constitution is to be improved by tonics and alterants, as quinine, iron, and the iodides. When all disease is arrested, the patient may exercise in the open air, the neck and head being well supported by appropriate apparatus.

The *atlo-axoid* articulation, enjoying a much wider range of motion than the preceding, is more liable to luxation by external violence, the most common causes being blows upon the back part of the head, forcible torsion of the neck, tumbling, and standing on the head, eventuating in rupture of the ligament of the odontoid process, and the projection of this process against the spinal cord, inducing fatal compression. Lifting children up by the occiput and chin, in play, may produce this accident, as in the memorable case related by J. L. Petit, of a little boy, who, being thus raised up in the air, struggled so violently as to dislocate his neck, dying on the spot. The nature of the lesion may be suspected when, by a sudden twist, blow, or wrench, the head is turned to one side, and cannot be restored to its natural position, the sterno-mastoid muscle being relaxed, and the part exquisitely painful. Unconsciousness usually succeeds the occurrence, and the patient, if not promptly relieved, soon expires. When the symptoms are urgent, an immediate attempt should be made to reduce the dislocation by inclining the head towards the side to which it is directed, in order to disengage the articular processes, a most hazardous step of the operation, and one which may instantly cause death by compression of the spinal cord. The processes being liberated, the head and neck are next brought to their natural position by rotating them gently in a direction contrary to that in which the luxation occurred.

Finally, there is occasionally a species of *subluxation* of the spine, consisting, as the name implies, in a partial displacement of the vertebræ, most frequently met with in the dorsal region. It may be caused by injury applied directly to the part, or, indirectly, through a fall upon the buttocks, in which these structures and the body are forcibly pushed towards each other, the violence of the shock being concentrated upon the ligaments, which, being thus forcibly rent asunder, leave a corresponding gap between the contiguous spinous processes. The accident is generally attended with severe concussion, and, occasionally, even with compression, of the spinal cord, thereby seriously endangering the patient's life. Sometimes there is partial paralysis, with retention of urine, and other unpleasant symptoms. The treatment is by recumbency upon a soft hair mattress, with the application of leeches and medicated lotions to the seat of the injury, and such internal remedies as the particular exigencies of the case may seem to demand.

DISLOCATIONS OF THE RIBS AND COSTAL CARTILAGES.

Dislocations of the costo-vertebral articulations from external injury must be extremely rare, if, indeed, they are not altogether impossible. That this is true, any one may satisfy himself by inspecting the mode in which the ribs are connected to the vertebræ; the ligaments are both numerous and powerful, and, besides, each joint is protected by a great thickness of muscles, so that these bones, instead of yielding at their junctions, will be much more apt to give way in their continuity. The possibility, however, of the accident was not only admitted, but strenuously maintained, by many of the older surgeons, especially by Paré, Barbette, Platner, and Heister, in whose works may even be found an account of what they regarded as varieties of the lesion. But modern experience is entirely opposed to such a conclusion; in truth, there are altogether not more, perhaps, than half-a-dozen well-authenticated cases of dislocation of the costo-vertebral articulations upon record, and in nearly every one of these the injury was associated with fracture of the ribs, or of the ribs and spine; all proved fatal, and in none was it possible to make a satisfactory diagnosis during life. Such an accident must, therefore, be entirely beyond the resources of surgical art; even if it were possible to detect the nature of the affection, still it would be impracticable to remedy it, except upon general principles, any direct interference being out of the question.

Dislocation of the ribs from their cartilages, and of the latter from each other and from the sternum, is also a rare occurrence, although not as much so as displacement of the costo-vertebral articulations. I have myself seen several cases of the kind, one of which I attended along with Dr. J. R. Pirtle, the patient being a man, sixty years old, who fell from a scaffold, a distance of ten feet, upon the stone steps below, his left shoulder and chest receiving the blow. Immediately after the accident there was violent dyspnœa, and the patient heard and felt, at every inspiration, something snap and jerk in his side, similar to the noise caused by pulling a finger-joint. Upon examination, this was found to proceed from a dislocation of the cartilages of the last three ribs from the sternum, the pieces playing to and fro during the movements of the chest. A fracture also existed in the left clavicle. In another instance the third and fourth ribs on the right side were severed from their cartilages. The remarkable case related by Sir Charles Bell, in his Surgical Observations, in which all the ribs were dislocated from their cartilages by the thorax being violently compressed between a wall and the beam of a mill, is familiar to every surgeon. Occasionally the costal cartilages are separated from each other.

Whatever form these costal dislocations may assume, their existence necessarily implies the infliction of severe injury, which cannot fail to tell badly upon the soft parts, both externally and within the chest, and to be followed, when not immediately fatal, by violent inflammation. Hence, besides the attention required by the local mischief, great care is demanded on account of the state of the system; in the first instance, to bring about reaction, and, secondly, to moderate the resulting excitement by appropriate antiphlogistics. The topical treatment is by bandage and compress, as in fracture of the ribs, the patient being compelled to breathe chiefly with the aid of the diaphragm.

DISLOCATIONS OF THE PELVIS.

Notwithstanding the great extent of the *sacro-iliac* surfaces, and the vast strength of the ligaments by which they are connected together, observation has demonstrated that they may occasionally be displaced along with the pubic symphysis, by external violence. Dr. Thomas Harris, of this city, met with a case of dislocation of these bones in a woman, thirty-five years of age, from a blow upon the sacrum inflicted by the husband's fist. In general, however, a much greater amount of force is necessary to produce such an accident, and hence there must almost always be more or less contusion of the soft parts, both externally and internally, extensive ecchymosis, concussion of the spinal cord, injury of the sacral nerves, and fracture of some of the pelvic bones, thus seriously, if not fatally, complicating the case. Even when the patient survives the immediate shock of the accident, he is very liable to perish from the subsequent inflammatory and suppurative irritation, perhaps weeks after the primary effects have passed off.

Violent kicks or blows, and compression of the body between two hard and resisting objects, as a wall and a carriage, are the usual causes of this dislocation. The displaced bone is thrown backwards and upwards, forming a distinct prominence beneath the skin, easily perceptible by sight and touch, and attended with marked crepitation. The limb of the affected side is shortened and powerless, the crest of the ilium is raised beyond the

natural level, the fold of the natis is flattened, the tuberosity of the ischium is higher than that on the sound side, and the ramus of the pubic bone lies somewhat posterior to the plane of its fellow. The parts are contused and exquisitely painful, and the patient is unable to lie upon his back, or to void his urine.

In the treatment of this luxation, the most important object, that, indeed, upon which the safety of the patient mainly depends, is to prevent the ill effects of inflammation, by the observance of perfect rest and the most rigid antiphlogistic course, of which leeching, anodyne fomentations, and blisters form most valuable constituents. When the inflammation has been measurably subdued, the parts should be covered with an ammoniac and mercurial plaster. The reduction, which is easily effected by pressure, is maintained by a compress and broad immovable bandage, secured, if necessary, by thigh and shoulder straps. Great attention must be paid to cleanliness, as defecation will be both painful and inconvenient; and the urine must be regularly drawn off with the catheter. In a case mentioned by Hoin, the articular surfaces refused to come together until after the patient had begun to walk about, when the weight of the limb drew them gradually in place.

The *pubic symphysis* is sometimes wrenched open by external violence, as I have witnessed in several cases in persons crushed between a railway car and the edge of the floor of the depot. The accident is generally fatal, not so much on account of the injury done to the joint and bones as of the violence sustained by the contents of the pelvic cavity. The treatment must be conducted upon the same principles as in dislocation of the sacro-iliac symphysis.

A separation of this joint occasionally occurs during utero-gestation, from softening of its fibro-cartilage, allowing the two bones to ride slightly upon each other, as in a case under my observation in a woman in her fifth pregnancy. The dislocation, beginning about a month before her confinement, was so great that she could not walk, or turn in bed, without severe suffering. The parts were exquisitely tender on pressure, and upwards of five weeks elapsed after parturition before they regained their healthy condition. Rest, recumbency, and leeches constitute the proper treatment, aided, when the patient is able to move about, by a belt with a pad upon the pubes.

The *coccyx* may be dislocated from the sacrum by external violence, as a fall, or kick, or by the pressure of the child's head in difficult parturition. The bone is usually thrown forwards or backwards. In a case reported by Dr. Roeser, it was displaced laterally, being torn away from the sacrum, and carried over towards the descending branch of the left ischium, where it formed a small but distinct tumor. The signs of the accident are, preternatural fixedness of the coccyx, with considerable shortening, difficulty in voiding the feces, tenesmus, and retention of urine. Reduction is effected by introducing the index and middle fingers of one hand into the rectum, while with the assistance of the fingers of the other, applied externally, the bone is pushed into its proper position. Rest, fomentations, and leeches will be required during the after-treatment. The bowels should not be moved for a number of days, and then only by means of saline cathartics and enemas, as all motion and straining would interfere with the reparative process and might even reproduce displacement.

2. SUPERIOR EXTREMITY.

DISLOCATIONS OF THE HAND.

Dislocations of the *thumb*, especially of its metacarpo-phalangeal joint, are, in many respects, so peculiar as to require separate consideration. Displacement of the phalanges backwards is by far the most common, the disposition of the articular surfaces, and the ligaments by which they are connected together, rendering luxation forwards or laterally extremely difficult.

In luxation of the metacarpo-phalangeal joint, the head of the first phalanx is thrown backwards, as in fig. 649, upon the dorsal surface of the metacarpal bone, generally by violence applied to the distal extremity or to the palmar surface of the thumb, while the joint is immoderately extended. The metacarpal bone being thus impelled by the weight of the body, and the proximal phalanx by the object struck, causes the ligaments to give way, and the articular extremities to glide past each other. It has been

Fig. 649.

Dislocation of the Thumb on the Dorsum of the Metacarpus.

asserted that, when there is inordinate relaxation of the ligaments, mere muscular action is capable of producing the displacement, but the possibility of such an occurrence, especially in its complete form, is very questionable.

The deformity which attends this luxation is so peculiar as to be characteristic. A large tumor, hard and circumscribed, and formed by the head of the first phalanx, exists upon the back of the joint, while another, equally hard, but not quite so distinct, is perceptible on the palmar aspect of the thumb, representing the distal extremity of the metacarpal bone ; the thumb is sensibly shortened, and can generally neither be bent nor extended, its last phalanx, however, being usually flexed in consequence of the excessive tension of the tendon of the long flexor muscle. In most cases the head of the first phalanx will be found to rest upon the posterior and inner part of the metacarpal bone, and not, as is commonly alleged, altogether upon its dorsal surface, a circumstance which gives the thumb an appearance as if it were rotated a good deal inwards. The shortening of the member often amounts fully to one inch, thus giving it a stumpy, characteristic aspect.

The ligaments in this luxation are extensively ruptured, particularly the anterior : the extensor tendons are pushed backwards, and strongly stretched ; and the external head of the short flexor muscle is torn in two, allowing the end of the metacarpal bone to pass completely through its fibres. The anterior ligament remains attached to the sesamoid bones and the first phalanx, the latter of which, as it is thrust backwards during the accident, carries both along with it, so as to deposit them, as it were, between its anterior surface and the contiguous surface of the metacarpal bone. In this way a partition is formed by these parts between the two bones, extending back some distance, and constituting, as Mr. Lawrie, by whom this arrangement has been so well described, justly remarks, a serious mechanical obstacle to replacement.

The means that were formerly employed to effect the reduction of this dislocation, were often so severe as to inflict the most dreadful injury, sometimes followed by extensive erysipelas and even mortification. Instances, in fact, were not wanting in which the thumb was pulled off during the violent and long-continued efforts at restoration. In many cases, again, the parts were obliged to be left in their unnatural situation. Desault, in order to accomplish his purpose, in difficult cases, suggested the idea of making an incision behind the extremity of the dislocated bone, and raising it out of its position by means of a suitable lever ; and Evans went so far as to propose its removal altogether by excision. Charles Bell, on the other hand, attempted to remedy the evil by the subcutaneous section of one of the lateral ligaments, an operation which has frequently been performed successfully both in this country and in Europe. Sir Astley Cooper advises, after a fair trial of the ordinary means, an abandonment of the case, under the idea that the patient will eventually have a useful thumb without reduction. I allude to these views simply because they serve to show the great difficulty which so often attends this dislocation, and the harsh expedients suggested for overcoming it.

The most common method of effecting replacement is that by extension and counterextension. This plan has always answered admirably in the few cases of the accident which I have had to treat. The extension should be made by means of the clove-hitch, represented in fig. 650, secured over a wet cloth, or piece of buckskin, to protect the soft parts, and the counterextension with a stout silk handkerchief, the fold resting in the palm of the hand, while the ends, crossed behind the wrist, and brought around the front of the forearm, are held by an assistant. In this way the two forces may be applied with

Fig. 650.
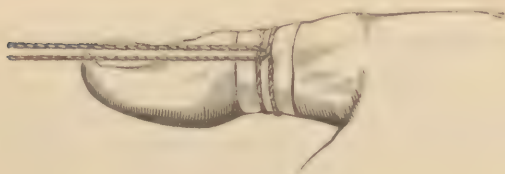
Clove-hitch Knot.

great effect, in a line with each other, and without the risk of unduly exciting the muscles concerned in the displacement. After they have been in operation for a short time, the thumb should be inclined inwards, in a semicircular direction, towards the ulnar margin of the hand, at the same time that the dislocated head is urged forwards and downwards by the surgeon's own thumb. Powerful extension may also be made by means of Charrière's forceps, fig. 651, and Dr. Levis's apparatus, the latter of which, delineated in fig. 652, is constructed upon the principle of the spatha, so much employed by the older surgeons for reducing dislocations of the shoulder. It consists of a flat, narrow piece of hard wood, ten inches in length, the proximal extremity

of which is perforated on each side for the passage of two strong tapes, two feet long. Properly applied, as shown in fig. 653, the apparatus acts with great efficiency, afford-

Fig. 651.

Charrière's Forceps.

ing a powerful leverage, perfectly unyielding, and in every respect superior to the clove-hitch.

The reduction is sometimes easily effected by abduction and rotation of the thumb, the extension being maintained in the usual manner. If the effort fail, trial should next be

Fig. 652.
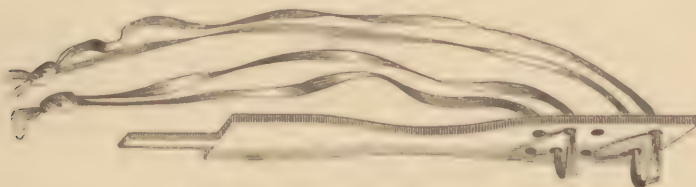
Fig. 653.

Levis's Apparatus for reducing Dislocations of the Thumb and Fingers.

made of the excellent method of Professor Crosby, of New Hampshire, originally practised in 1826. It simply consists, as the adjoining cut, fig. 654, clearly exhibits, in pushing the phalanx back, until it stands perpendicularly on the metacarpal bone, when, by strong pressure directed against its base, from behind forwards, it is readily carried by flexion into its natural position. If this plan also fail, the only resource is the subcutaneous division of the tendon of the long flexor muscle, which is frequently, if not generally, the chief obstacle to replacement.

Fig. 654.

Crosby's Method of Reduction.

Fig. 655.

Forward Dislocation of the Thumb.

The annexed sketch, fig. 655, exhibits a plan of the dislocation of the head of the phalanx of the thumb forwards towards the palm of the hand. As already stated, it is an occurrence of great rarity. The symptoms are characteristic.

Dislocation of the *trapezio-metacarpal* joint may occur in four different directions, the end of the metacarpal bone being thrown off from the articular surface backwards, inwards, forwards, or outwards; the first two forms of the accident, however, are by far the most common, as will be apparent from an examination of the structure of the articulation and the arrangement of the muscles stretched along its anterior and outer surface.

Luxation *backwards* is always occasioned by external injury, as a blow or fall upon the dorsum of the thumb or the extremity of its metacarpal bone, by which the latter is sud-

denly and violently turned towards the palm. The signs of the accident are characteristic. A hard prominence is seen and felt upon the back of the trapezium, or at the posterior and radial surface of the hand, formed by the displaced head of the bone, the thumb is in a state of forced flexion, without the possibility of being extended, and the tendon of the extensor muscle is powerfully stretched, presenting itself as a firm, rigid cord behind the luxated bone. In order to effect reduction, two assistants are required; one to fix the hand by grasping the wrist, and another to pull the thumb with a clove-hitch. When the parts are thus drawn in opposite directions, the surgeon pushes the head of the bone forwards and downwards towards the palm, into its natural position. Sometimes the merest pressure from behind forwards and from above downwards is sufficient for the purpose. For some days the hand should be supported upon a broad splint, and means employed to moderate inflammation.

I have occasionally seen a partial dislocation of the metacarpal bone of the thumb backwards from inordinate relaxation of the ligaments. The occurrence is most common in weak, delicate women, and requires tonics, the cold douche, electricity, and a series of small blisters for its relief.

In the luxation *inwards*, which is exceedingly infrequent, the metacarpal bone of the thumb is wedged in between the trapezium and the head of the metacarpal bone of the index-finger, so as to extend the thumb, and cause the trapezium to form a projection at the outer and back part of the palm. In the reduction the extension and counterextension are conducted as in the preceding case, but they must be kept up a longer time, and, as the head of the bone approaches the trapezium, the thumb must be inclined towards the inner side of the hand, in order to relax the flexor muscles.

DISLOCATIONS OF THE FINGERS.

The phalangeal joints are susceptible of luxation backwards, fig. 656, an occurrence which can only be caused by severe force, and which is always so well characterized as

Fig. 656.

Dislocation of the Finger.

to render any description of the signs unnecessary. The reduction is effected by extension and counterextension, aided by pressure upon the head of the displaced bone. The accident is extremely rare. In a case under my charge of a compound dislocation of the last joint of the right middle finger, in a stout, healthy man, the injury was produced by a fall, in which the end of the finger was struck violently against the ground. The distal phalanx lay upon the posterior surface of the middle one, a large wound existing in front. The reduction was easily effected, and the parts being well approximated by suture and collodion-plaster, I indulged the hope of a good cure. Presently, however, severe inflammation set in, terminating in necrosis of the two bones, and I was obliged to amputate the finger immediately behind the joint.

In dislocation of the *metacarpo-phalangeal* joints, also a very uncommon accident, the phalanx is usually displaced backwards, its extremity resting upon the posterior surface of the metacarpal bone. Of the luxation forwards I have seen but one case, and that

Fig. 657.

Dislocation of the Finger at the Metacarpo-phalangeal Joint.

was of many years' standing; the finger was considerably shortened, and stood out in an extended position, flexion being impracticable. A rare example of luxation of all the fingers at the metacarpo-phalangeal articulation forwards has been reported by S. H. Serre, of Paris.

Dislocation backwards is generally caused by severe blows upon the back of the hand, or the extremity of the finger, while it is immoderately bent. The case is recognized by the existence of a hard tumor in the natural site of the knuckle of the hand, fig. 657, and by the shortened and flexed condition of the finger, the extension of which is impracticable.

The reduction is usually not difficult. To effect it, extension is made upon the finger by means of a suitable lac, fastened with a sailor's noose, and counterextension upon the hand, while firm and steady pressure is made by the surgeon's thumb upon the head of the displaced bone. When these efforts fail, recourse is had to Charrière's forceps or Levis's spatha, both of which may generally be used with admirable effect, as they are powerful means not only for securing a firm hold, but for controlling the movements of the finger during the necessary manipulations.

Excepting by the bursting of a gun, or other severe violence, dislocation of the *carpo-metacarpal* joints must be regarded as impossible, owing to the intimate manner in which the four last bones of the metacarpus are connected with each other, and with the bones of the second row of the carpus. Under such circumstances the injury is generally so great as to require amputation or excision, the latter operation always taking precedence when it is in our power to save any portion of the hand likely to be of service to the patient. Conservative surgery may do much in these cases to prevent mutilation by a careful use of the knife and pliers immediately after the occurrence of the accident, when the parts are tolerant of manipulation, and admit of being put in proper form for speedy reunion. A surgeon who cuts off a whole hand when the removal of a portion will suffice, has no just conceptions of his duty.

DISLOCATIONS OF THE CARPAL BONES.

From the firm connections and limited motions which characterize the carpal joints, it is evident that any displacement of them must be of very uncommon occurrence. Indeed, it was formerly asserted that such an accident was altogether impossible; a statement which has been contradicted by modern experience, which has not only established the fact, but elucidated the pathology and treatment of the lesion. The bones most liable to suffer in this way are the magnum, cuneiform, and pisiform, the occurrence being nearly always preceded by a relaxed condition of the ligaments, weakening their connections, and predisposing them to displacement under the application of comparatively slight force. The luxation is seldom complete. Maisonneuve has related a case in which the second row of carpal bones was dislocated posteriorly from the first row ; and a few examples of a similar kind exist in the annals of surgery.

Of the three bones above mentioned, the *magnum* is the most liable to dislocation : women are supposed to be more subject to it than men, owing to the greater mobility of the carpal joints, and the weaker state of the ligaments. The accident, which always occurs in a backward direction, is caused by forced flexion of the wrist, from falls, or other injuries, upon the back of the hand, wrenching the bone from its connections with the head of the corresponding metacarpal bone, and pushing it out behind, where it forms a hard, well-defined tumor, which increases when the wrist is bent, and diminishes when it is extended. Several cases have been observed in which the accident happened during the throes of parturition while the woman was forcibly grasping some substance with her hand; and in an instance related by Bransby B. Cooper, the person possessed the faculty of luxating this bone at pleasure. The displacement, although always incomplete, is apt to be followed by severe tumefaction, which often temporarily obscures the diagnosis.

The reduction is effected by firm pressure, either with a tourniquet or some other suitable contrivance, applied to the bone from behind forwards, or in a direction contrary to that of the displacement, the hand being at the time in an extended state, in order to insure greater relaxation of the soft parts, and to increase the opening from which the bone has been ejected. The operation must be conducted with great gentleness, and the surgeon must not be disappointed if he do not succeed in his first attempt. In case there is much inflammation, leeches and fomentations will probably be required. To maintain the reduction, the hand must be placed in a straight position, upon two binder's board splints, well padded, and long enough to extend from the middle of the forearm to the ends of the fingers. If the tendency to displacement is very strong, as it usually is, it may be necessary to apply a compress directly to the luxated bone, with a view to a more direct concentration of the pressure. The apparatus must be worn for a long time, as the ligaments are very slow in uniting, but after the first fortnight it should occasionally be taken off, for the purpose of moving the wrist-joint, to prevent ankylosis.

Of dislocations of the *semilunar* bone, complete and uncomplicated, only a few examples are upon record. In a case observed by Professor Chisholm, of Baltimore, the accident was caused by a fall from a height of twenty-five feet upon the hand. The bone formed a hard tumor immediately beneath the skin, just above the last fold of the palmar surface

of the wrist, on a line with the radius. The fingers were partially flexed, and could not be extended. A corresponding cavity existed on the back of the hand. As reduction was found to be impracticable, owing to the complete rotation of the bone, excision was performed, an operation rendered unusually difficult on account of the very tense condition of the numerous ligamentous connections. Notwithstanding this an excellent recovery followed.

A singular case of compound luxation of this bone has been reported by Mougeot. A carpenter, in a fall from a height of thirty feet, upon the palm of the hand, received a wound half an inch in length near the wrist-joint, attended with an escape of the semilunar bone, which, as it adhered only by a few ligamentous threads, was readily removed. The wound speedily healed, and the man recovered with a good use of the hand.

In a case of compound dislocation of this bone which I attended with Dr. M. O'Harra, the accident was caused by a fall from the platform of a railway car under motion, in which the patient, a stout young man, struck his hand upon a rock. A wound, half an inch in length, occupied the ulnar side of the wrist. Erysipelas and pyemia ensued, placing life for some time in imminent peril. As the case did not come under our charge until two days after the receipt of the injury, when the parts were excessively painful and swollen, no attempt could be made at reduction, and as the bone was attached only by a few shreds of ligamentous structure it was subsequently removed. Extensive suppuration occurred during the progress of the case, and the patient was a long time in regaining his health, with a tolerably fair use of his fingers. Bryant refers to a case in which both semilunar bones were dislocated simultaneously in a fall upon the hands.

Dislocation of the *cuneiform* bone is exceedingly uncommon; the accident can only occur when great force is applied, and must be treated upon the same general principles as the preceding.

The *pisiform* bone may be partially luxated by the action of the flexor muscle of the carpus, when its connections have been seriously weakened by disease of its ligaments. The occurrence is attended with some annoyance, and is difficult to remedy. When it is of sufficient importance to claim attention, the best plan is to place the hand in a slightly flexed position, in a wire case, extending from the middle of the forearm to the metacarpophalangeal joints, the carpal piece being so arranged as to form an obtuse angle with the other. A compress is applied to the lower and inner part of the wrist, in the situation of the displacement, and confined by adhesive strips and a bandage.

A case in which this bone was dislocated by an effort to lift a heavy weight, and drawn up the arm to a distance of nearly an inch by the flexor muscles of the carpus, is related by Mr. Erichsen. Similar instances are recorded by South, Fergusson, and other surgeons. When, after such an occurrence, restoration is impracticable, and the bone is in the way of usefulness, the best plan will be to excise it.

DISLOCATIONS OF THE WRIST.

A dislocation of the wrist-joint, as an independent traumatic lesion, is an exceedingly uncommon occurrence. Dupuytren, in the early part of the present century, after the dissection of a number of cases simulating this accident, positively asserted that he never saw an instance of it, except as a result of organic disease of this articulation. He assured himself that the pretended cases reported by various writers were simply examples of fracture of the inferior extremity of the radius, an accident which, as every one knows, is of very frequent occurrence, and is generally attended with symptoms closely resembling those of luxation of the wrist-joint. Observations, however, made since the time of the celebrated French surgeon, both in Europe and this country, indisputably prove that, although the lesion is exceedingly uncommon, its occurrence is not only possible, but that it has repeatedly been made the subject of clinical study. Luxation of the ulna alone, as a concomitant of fracture of the lower end of the radius, is sufficiently frequent.

The reason of the great infrequency of this accident is altogether of an anatomical character. From the manner in which the lower extremity of the radius is connected with the scaphoid, semilunar, and cuneiform bones, it is evident that any severe force applied to the hand, as in falls upon the palm or dorsum, must promptly be transmitted through the carpus to the radius rather than to the ulna, which can hardly be said to enter into the composition of the joint at all, except in so far as it affords some degree of lateral support. The consequence is that the radius, receiving the brunt of the injury, usually gives way at its inferior extremity, instead of allowing itself to be dislocated;

fracture of the brittle osseous matter being generally much easier than the laceration of the strong ligaments which naturally tie the contiguous surfaces together.

The carpal bones may be displaced from the radius and ulna backwards and forwards; lateral luxation cannot occur without fracture of one of the styloid processes, and then only in an incomplete manner.

In the luxation *backwards*, the carpal bones are driven up behind the ends of the two bones of the forearm, which lie in front of the muscles of the thenar and hypothenar eminences; the consequence is that there is great deformity of the wrist-joint, its antero-posterior diameter being much increased, although its breadth is nearly natural. The forearm is somewhat shortened, the hand and fingers are forcibly flexed, and the ulna is thrown considerably forwards and inwards beyond the line of the carpus. The radius and ulna retain their normal length, and the prominence on the back of the joint is characteristically hard, convex, and transversely elongated.

Fig. 658.

Dislocation of the Carpal Bones Forwards.

In the dislocation *forwards*, fig. 658, from Erichsen, the symptoms just described are reversed, the carpal bones lying in front, and the end of the radius and ulna behind. The hand and fingers are powerfully extended, the distance between the elbow and wrist is sensibly diminished, although the two bones retain their proper length, and the styloid processes can be distinctly felt behind at the lateral aspect of the hand, with the articular groove which naturally separates them, and which is now occupied by the tightly stretched extensor tendons.

These two dislocations are liable to be mistaken for fracture of the lower extremity of the radius and ulna, although such an accident could hardly happen in the hands of a scientific surgeon, perfectly vigilant, and bent upon the discharge of his duties. The principal points of distinction are, that, in luxation, there is much more of a tumor than in fracture, that the tendons of the hand and fingers are more evidently affected, being either violently extended or flexed, that the radius and ulna retain their normal length, and that the bones are, as it were, firmly interlocked with each other. In fracture of the radius, or of the radius and ulna, on the contrary, the deformity is less marked in the antero-posterior diameter, the two bones, if both are broken, are sensibly shortened, there is much more mobility, and, upon bringing the fragments in contact with each other, and then grasping the lower part of the forearm with one hand, while the patient's hand is moved with the other, crepitation may readily be elicited. Moreover, in luxation the styloid process of the ulna generally lies upon a plane somewhat anterior to that of the radius, whereas in fracture it is behind that bone.

The reduction of these two dislocations is sufficiently easy. All that is required is to extend the hand and counter-extend the forearm, immediately above its middle, while pressure is applied by means of the thumbs upon the carpal bones in a direction opposite to that of the displacement. The limb, enveloped in a roller, is supported upon a light splint, stretched along its palmar aspect, and kept constantly wet with some evaporating lotion. Ankylosis, so liable to occur after all injuries of this joint, is prevented by passive motion.

Congenital dislocations of the wrist have attracted much attention, chiefly through the labors of Dupuytren, Cruveilhier, Guerin, R. W. Smith, and Robert Adams, of Dublin, the latter of whom states that he saw within a few years, not less than thirteen examples of it. The carpal bones may be thrown forwards or backwards, forming, in either case, a well-marked, characteristic, angular prominence. The lesion is attended with atrophy of the bones, ligaments, and muscles; the hand is generally useless, and the fingers are variously deformed, being usually wasted and crooked. I lately saw a well-marked case of lateral displacement of the wrist in a puny female infant, three weeks old, the hand presenting towards the radius. The treatment must be conducted upon general principles, although it will seldom be of much avail.

DISLOCATIONS OF THE RADIO-ULNAR JOINTS.

1. The *inferior radio-ulnar* joint is liable to displacement in two directions, the ulna being thrown backwards in the one case, and forwards in the other, beyond the line of the

radius. The slightest anatomical inspection will serve to show, what experience has proved to be true, that the former luxation must be the more frequent of the two, although both are very rare as uncomplicated lesions. As an accompaniment of fracture of the lower extremity of the radius, displacement is by no means uncommon, especially the partial variety.

The dislocation *backwards* is usually the result of violence applied to the hand or forearm, during strong pronation, any sudden twist or wrench of the joint predisposing to its occurrence. The signs are characteristic. The hand is in a fixed state of pronation, and inclined a little towards its inner margin; the head of the ulna, directed obliquely across the radius, forms a distinct prominence above the level of the cuneiform bone; the fingers are slightly bent; the styloid process has lost its parallelism with the fifth metacarpal bone; and the inferior extremity of the forearm has an appearance of being unnaturally narrow, although, if some time has elapsed since the accident, this will probably be masked by the swelling. The reduction is effected by flexing the forearm at a right angle with the elbow, and then gradually but determinedly extending the hand, and rotating it outwards until it is brought into the supine position, when the bone will usually resume its natural relations.

The lower extremity of the ulna may be displaced *forwards* by a fall upon the wrist, by a violent wrench of the hand while in a state of supination, or by injury applied directly to the forearm. The accident is very uncommon. The symptoms are the reverse of those in the preceding dislocation; that is, the ulna, lying across the anterior part of the radius, forms a remarkable projection just above the carpus, while the forearm and fingers, slightly bent, are powerfully supinated, and cannot be brought out of this position without restoring the joint to its normal condition. The reduction is effected in the same manner as in the luxation backwards, the limb, as the bone yields, being gradually but forcibly pronated.

It will be necessary after both these luxations, as the ligaments will be slow in uniting, to keep the limb well bandaged, and supported by means of a padded splint, extending from near the elbow to the ends of the fingers. A firm compress is to be placed over the inner and forepart of the joint, the more thoroughly to protect it against a recurrence of the accident.

2. Dislocation of the *superior radio-ulnar* joint may occur in three different directions, the head of the radius being thrown from the sigmoid cavity of the ulna forwards, backwards, and outwards, the frequency of the accident being in the order here stated, although some authorities contend that the displacement backwards is the most common. This I have not found to be the case in my own practice.

The chief causes of dislocation *forwards*, fig. 659, are falls upon the palm of the hand, in which, the forearm being powerfully supinated, the head of the radius receives the whole force of the blow, and is thrown against the coronoid process of the ulna and the external condyle of the humerus. The accident, which is most common in young subjects, may also be produced by direct injury to the upper extremity of the bone, acting from behind forwards, as in the case of an elderly gentleman, recently under my observation, in which the luxation was caused by the kick of a horse which at the same time fractured the upper portion of the shaft of the ulna. Dr. Krackowizer, of New York, has recorded a case in which the displacement was occasioned, as was supposed, by violence inflicted in turning the child in delivery.

Fig. 659.

Dislocation of the Head of the Radius Forwards.

The signs of this accident are characteristic. There is an obvious vacuity at the upper and outer part of the limb, and the head of the radius can be distinctly felt in its new situation, in front of the elbow, rolling about under the finger, upon rotating the lower extremity of the bone. The forearm, slightly flexed, is either pronated, or in a state midway between pronation and supination, and every attempt to bring it into a straight line or to a right angle with the elbow is unsuccessful. When an effort is made to bend the limb suddenly, the head of the radius will be found to strike against the lower and fore part of the humerus, refusing to advance; a circumstance characteristic of the nature

of the accident. This dislocation is usually described as being accompanied by forced supination of the hand, but, in general, this is not the case.

The reduction is best accomplished by applying extension to the hand and counterextension to the middle of the arm, while the forearm, being semiflexed, in order to relax the two-headed flexor muscle, is forcibly supinated, at the same time that the head of the radius is pushed downwards and backwards, in the direction of its natural position. Replacement is often exceedingly difficult, and sometimes even impracticable; and, owing to the extensive laceration of the soft parts, there is a great tendency to a recurrence of the accident after the reduction has been effected, with imperfect recovery of the functions of the joint.

The most common cause of luxation *backwards*, fig. 660, is violence applied to the hand when the forearm is in a state of pronation, and carried beyond the natural line of the body. The accident is often associated with fracture of the condyle of the humerus.

The peculiar attitude of the limb in this luxation is almost characteristic of the nature of the injury. The forearm is semiflexed, and, together with the hand, in a fixed state of pronation; the fingers are also somewhat bent, and there is an evident void at the upper and outer part of the forearm, just below the elbow, while a short distance beyond this, over the external condyle, by the side of the

Fig. 660.
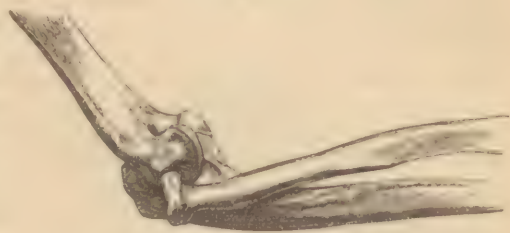
Dislocation of the Head of the Radius Backwards.

olecranon process, the prominence formed by the head of the displaced radius is distinctly perceptible, feeling hard and firm, and but faintly responding to any motions that may be impressed upon the lower extremity of the bone. Any attempt short of what is requisite to effect the reduction, to supinate the limb, to bring it into a straight line, or to flex it at a right angle with the arm, will be quite abortive, owing to the manner in which the radius hitches against the humerus.

Reduction is effected by making extension upon the hand and counterextension upon the lower part of the arm in the line of the displacement, while the head of the radius is pressed from behind forwards, towards the lesser tubercle of the humerus, at the same time that the hand and forearm are gradually but forcibly supinated. When the patient has not been relaxed by anæsthesia, the return of the bone is always indicated by a distinct snap.

A dislocation of the radius *outwards* is exceedingly uncommon. It occasionally exists, in an incomplete form, as a result chiefly of a relaxed condition of the annular ligament in persons of a feeble habit of body. Complete luxation in this direction can only occur when there is a rupture of the upper extremity of the interosseous ligament, and hence the lesion is apt to be complicated with fracture of the humerus or ulna, and severe injury of the soft parts. A fall upon the palm of the hand, propelling the radius upwards and outwards, with the whole force of the leverage of this bone, is the most common cause of the accident.

The symptoms are generally unequivocal. The head of the radius, resting upon the epicondyle of the humerus, forms a distinct prominence at the outer part of the elbow, easily recognized by the finger; the bone is situated higher up than natural, the distance between it and the olecranon being materially increased; the forearm is in a state midway between pronation and supination, the latter of which is impossible; and the movements of flexion and extension are, of course, much impeded. Besides these signs there is always a cord-like prominence along the front of the radius, as well as on the inside of the displaced head, formed by the tension of the external radial and long supinator muscles, which is gradually lost upon the outer and anterior surface of the limb. The reduction is effected by pushing the radius downwards and forwards, the forearm being bent at a right angle, and extension and counterextension made in the usual manner.

The reduction of these radio-ulnar dislocations is frequently attended with great difficulty; and as they are extremely liable to recur from the slightest causes, it is of great consequence, during the after treatment, to guard against the accident by the use of the compress and bandage, aided by a suitable apparatus, to insure perfect quietude, until the ligamentous structures are reunited. Passive motion must not be neglected, otherwise ankylosis may ensue.

The superior radio-ulnar joint is liable to a species of *subluxation*, similar to that of the

temporo-maxillary. I have seen a number of well-marked cases of it, in several of which it existed simultaneously on both sides; and in all it was manifestly dependent upon a relaxed condition of the annular ligament, allowing too great a latitude of motion between the head of the radius and the sigmoid cavity of the ulna. The subjects of this displacement are, for the most part, thin, weakly children of a strumous habit of body, and my experience is that females are more frequently affected than males. The movements of the joint are not materially impaired by the occurrence, unless it persists and gets worse, when the whole limb may become enfeebled by it. The cold douche, tincture of iodine, electricity, and a series of small blisters, with tonics to improve the general health, are the most suitable remedies.

Another form of dislocation liable to happen in this articulation is the *partial traumatic*, as it may be termed, chiefly met with in young children, from a sudden jerk, pull, or twist of the forearm, when the limb is in an overstretched state of pronation, the small size of the sigmoid cavity of the ulna at this period of life, and probably also a relaxed condition of the ligaments of the joint, favoring the occurrence. The accident is usually caused by the nurse in lifting the infant over the gutter, in dragging it rudely up to her side, or in her attempts to prevent it from falling. The head of the radius may be thrown either backwards or forwards, but the former displacement is by far the more common. The symptoms are generally well marked. A slight noise or snap is usually noticed at the moment of the accident; the child screams and is in great pain; the limb hangs motionless by the side; the forearm is slightly flexed, and the hand, strongly pronated, cannot be supinated without excessive suffering. There is ordinarily no swelling or deformity at the seat of the injury, not even after the lapse of several days.

The reduction, which occasionally occurs spontaneously during sleep, or during the manipulation necessary to detect the nature of the accident, is readily effected by extension and counterextension at the hand and lower part of the arm, while an effort is made to force the forearm into a state of supination.

DISLOCATIONS OF THE ELBOW.

The dislocations of the elbow-joint form a subject of very deep interest, not only on account of the frequency of their occurrence, but because of their great liability to serious complications and the consequent difficulty of their diagnosis and treatment. I am satisfied, from no little observation, that there are no luxations which are so little understood or so unscientifically managed. The principal reason of this is the want of correct knowledge of the structure of the elbow-joint, and of the complex arrangement of its osseous elements, with which few practitioners take the trouble to make themselves acquainted. The result is that cases of dislocation constantly occur which are mistaken for fracture, and which are, therefore, entirely neglected until it is too late to remedy them by means which, if timeously employed, would nearly always be sufficient to insure the reduction of the displaced bones, and the restoration of the bruised and lacerated tissues, with complete recovery of the functions of the articulation. It has been my lot to witness an unusually large number of such cases, generally at a period when nothing could be done for their relief.

The most common dislocation of the elbow is that in which both bones of the forearm are thrown upwards and backwards against the posterior surface of the humerus. Dis-

Fig. 661.
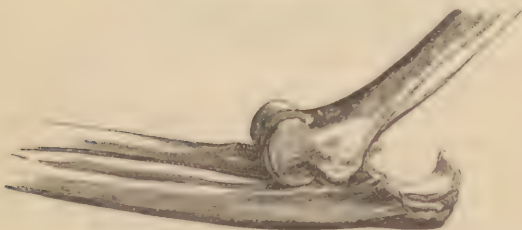
Dislocation of both Bones Backwards.

placement forwards is exceedingly infrequent, as it can only occur, with very rare exceptions, when the accident is complicated with fracture of the olecranon process, whereby the ulna is permitted to glide in front of the joint, which it must do with great difficulty when its superior extremity remains intact. Lateral luxation of both bones of the forearm from the condyles of the humerus is also very uncommon, and is necessarily incomplete, owing to the great extent of the articular surfaces in this direction, and the number, size, and strength of the muscles and ligaments surrounding the joint. Of the displacements of the superior radio-ulnar articulation a sufficient account has already been given. The ulna alone is sometimes luxated

upwards, the olecranon forsaking the sigmoid fossa of the humerus, and applying itself against the posterior surface of that bone.
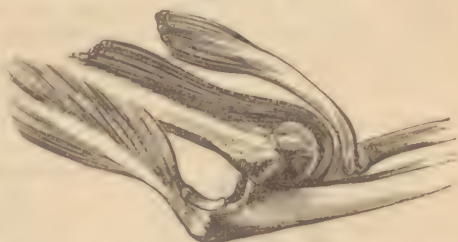
1. Dislocation of both bones of the forearm *backwards*, fig. 661, or, more correctly speaking, backwards and upwards, usually occurs from falls in which the person, instinctively stretching out the arm to protect the body, receives the whole shock upon the palm of the hand. The two bones being thus impelled by the surface struck by the hand, and the humerus by the weight of the body coming in the opposite direction, the two forces explode at the elbow-joint, rupturing the ligaments, and driving the olecranon and head of the radius backwards and upwards. There can be no doubt that a contorted state of the forearm at the moment of the accident greatly promotes the luxation by increasing the strain. The accident sometimes occurs at a very early period of life, as in a case recently brought to my clinic, in a boy six years of age. Professor W. T. Briggs, of Nashville, met with it in a child only two years and a half old.

The signs of the dislocation are sufficiently obvious, presenting little variation in their character, unless the accident is conjoined with other injury. There is always great deformity at the elbow, and the forearm is generally in a partially flexed position. At the posterior part of the joint is the unnatural projection formed by the olecranon, and, in front, the still more conspicuous one formed by the condyles of the humerus, fig. 662, both usually perceptible by sight and touch, especially in lean subjects, and before the supervention of swelling. The forearm has generally a slightly twisted appearance, and occupies a position midway between pronation and supination, inclining, however, more to the latter than to the former; any attempt to flex or extend it is not only very

Fig. 662.

Dislocation of both Bones Backwards, showing the manner in which the muscles are put on the stretch.

painful, but in great measure impracticable. The fingers are somewhat bent, and the distance between the elbow and wrist is sensibly diminished, generally from an inch to an inch and a half, but only in front, for behind the limb retains its normal length. The muscles in front of the joint, especially the flexor and brachial, are stretched like tense cords over the condyles of the humerus, while the tendon of the three-headed extensor is carried away from the bone behind, and stands out in bold relief, forming one of the most conspicuous signs of the accident, as seen in fig. 662. Although generally the forearm is partially flexed and nearly immovable, occasionally it is almost straight, and can readily be bent and extended, not, however, without great pain.

Notwithstanding that the signs of this dislocation are usually characteristic, cases, nevertheless, occasionally occur in which the diagnosis is painfully obscured. Two circumstances principally contribute to render it so. One is the inordinate swelling which so generally follows the accident, and which is often present in a high degree before the surgeon has had an opportunity of examining the parts; the other, the existence of fracture of the bones composing the joint. When the humerus is broken off just above the condyles, the deformity closely simulates that produced by a dislocation backwards, the lower fragments, with the radius and ulna, being drawn in that direction, so as to give the back of the elbow a very prominent and distorted appearance, while the upper fragment will present itself quite conspicuously in front, under the flexor muscles. The points of distinction are that, in dislocation, the parts are fixed, and cannot be restored without a good deal of force, whereas, in fracture, they are easily moved and replaced, returning, however, to their unnatural situation the moment the efforts are discontinued. In dislocation, moreover, there is actual shortening of the anterior part of the forearm, but none in fracture; nor is there, in the former, any crepitation, which is so conspicuous in the latter. Fracture of the olecranon can always be distinguished by the elevation of the upper fragment, and the wide gap which separates it from the lower, and by the facility with which the surgeon can flex and extend the forearm. In fracture of the head of the radius there is no deformity of the posterior part of the elbow, and by grasping the bone with the thumb and finger above, as it is being rotated below, crepitation may easily be elicited, thus at once clearing up the diagnosis.

The reduction of this dislocation is extremely easy, if attended to immediately after its occurrence, but very difficult if it be neglected even for a short time. I have never been foiled in a recent case, but have met with many examples where every attempt

proved unavailing after the third week, and sometimes, indeed, even by the end of the second. I am not prepared to assign any reason for this; to say why a displacement that is always so easily rectified, if properly managed, in its earlier stages, should so soon become utterly irreducible, resisting and defying all the best directed efforts of the surgeon. It can hardly be supposed to be owing exclusively to inflammatory adhesions, for it is impossible that they could become either so extensive or so firm, in so short a time, as to produce such a result; but, whatever the true explanation may be, the fact remains, and the practical precept to be deduced from it is that all luxations of the elbow backwards should receive the earliest possible attention, their reducibility being in an inverse ratio to their duration.

But, although it is undoubtedly true that it is always extremely difficult, and sometimes utterly impossible, to reduce a dislocated elbow at the end even of two or three weeks after the occurrence of the accident, yet it would by no means be proper to abandon a case even if it were of three times that duration, inasmuch as a number of examples have been recorded which fully sanction such a course. I have myself met with several instances in which my efforts were rewarded, if not with complete success, certainly with very gratifying results, as it respected the functions of the joint, at the end of nearly two months. Sir Astley Cooper effected reduction at three months; Malgaigne, at three and a half; Blackman, Brainard, and Westmoreland, at five; Gerdy and Drake, at six. It is worthy of notice that the efforts, if long continued, may be followed by grave injury, as

Fig. 663.

Reduction with the Knee in the Bend of the Elbow.

violent inflammation, suppuration, and even gangrene. The brachial artery has been ruptured in more than one instance. Michoux, in an attempt to reduce a luxation of this joint, tore this vessel and the median nerve, and saved his patient only by immediate amputation of the arm. In a case treated by Velpeau, death was the consequence. Such examples teach a lesson which should not be lost upon the surgeon who is anxious to surmount obstacles at any and all hazard.

The reduction may be effected in various ways. The one that is usually adopted is to make a fulcrum of the knee in the bend of the arm, as in fig. 663, the patient being seated upon a chair, and the surgeon standing by his side in front, with his foot resting upon a high stool or upon another chair. Extension being made by grasping the lower portion of the forearm, the limb is gradually brought over the knee so as to disengage more effectually the ulna and radius from the condyles of the humerus. This manœuvre is usually very promptly successful. The efficiency of this method may be increased by steadying the shoulder with a sheet, the arm being passed through a hole in the middle.

A method which I have often successfully employed, especially in cases in which some time had elapsed, but which has not, so far as I know, been described by any one else, is to place the heel instead of the knee in the bend of the arm, the patient lying down, and the surgeon carrying his leg across the chest, while extension is made by pulling the hand and wrist. This procedure affords the operator an opportunity of exerting his strength to great advantage. As the bones yield, the forearm is bent towards the chest over the fulcrum, furnished by the foot, a step which materially promotes the reduction. The force of the extension may be much increased by securing a stout lac around the limb, immediately above the wrist, and throwing the noose over the neck and shoulder. Counterpressure may also be usefully made by an assistant placing his hands against the shoulder of the affected side.

A third method of reduction, based upon the same principles as the preceding, is to bend the limb forcibly round a bedpost, which is thus made to act as a fulcrum, while the requisite extension is made at the hand and wrist. This plan, however, although quite efficient, has the disadvantage of being both awkward and painful.

Finally, the reduction may often be readily effected by seating the patient upon a chair, and requesting two assistants to make extension and counterextension, one grasping the

wrist, the other the middle of the arm. The surgeon, standing behind the affected limb, then places his thumbs firmly upon the olecranon, and thus aids in pushing this process downwards and forwards into its natural position.

When unusual difficulty is anticipated, as when the patient is very muscular, or the luxation is several weeks old, the forearm may be carried forcibly backwards beyond the straight line, when, with very slight extension and counterextension, the parts will resume their natural relations. In a case in the hands of Dr. Waterman, of Boston, this method promptly succeeded after the failure of the more common procedures; and in one of my own, in a child six years old, a patient at the College Clinic, in which the dislocation was of five weeks' standing, I was equally fortunate, the reduction being effected in a few minutes. The coronoid process, in this method, being lifted out of the sigmoid fossa of the humerus, the muscles in front of the arm, by their tonic contraction, powerfully assist in drawing the bones of the forearm into their proper place.

When all these plans fail, the only resource is to employ the pulleys hooked to a noose fastened around the lower extremity of the forearm, and to a staple in the wall, floor, or bed. The counterextending band is secured around the middle of the arm, and is either confided to two stout assistants, or attached to some firm object behind the patient's head and shoulder. The patient should, of course, be recumbent, and fully anaesthetized. After the extending forces have been maintained for some time, the return of the bones will be promoted by steady pressure upon the olecranon. When these means fail, as will be extremely likely if the case is of longer standing than three weeks, it has been proposed to insert a narrow bistoury into the joint, so as to divide the resisting structures; but the operation, besides being dangerous, on account of the proximity of the brachial artery and nerves, has disappointed the expectations of its advocates.

Subcutaneous division of the tendon of the triceps has occasionally been practised with a view, as is alleged, of facilitating restoration of the joint. Professor Sayre, in 1871, reported two cases, respectively of fourteen and sixteen weeks, in which success seems to have followed such an operation. One of these cases was complicated with fracture of the coronoid process. Hamilton also succeeded in one instance in effecting, by this method, reposition in an old luxation. In a case of three months' duration in a girl eleven years of age, under my charge, in 1879, the operation signally failed, although I had previously divided the posterior and external lateral ligaments of the joint, and employed every possible justifiable means to accomplish my object. It is difficult on ana- tomical principles to conceive how such an operation could do any good, when it is remembered that the triceps in this accident is always relaxed by the posterior projection of the olecranon process.

Reduction being effected, the limb, carefully bandaged, is supported in a light wire case, and kept constantly wet with evaporating lotions. If the inflammation run high, as it generally does after such an injury, leeches and even venesection may become necessary. In every case, however simple, the greatest vigilance must be employed to prevent anky- losis. Passive motion must, of course, receive early attention.

In decidedly chronic cases of this accident, but where there is still a good deal of motion, the patient may often obtain a very fair use of the joint by breaking the olecranon process by forcible flexion of the limb. I have pursued this plan with excellent results in several instances, and equally encouraging effects have attended it in the hands of Crosby, Mus- sey, and other surgeons. In one case, I divided the bone subcutaneously, and, although a slight attack of erysipelas followed, good motion was obtained.

2. Dislocation of both bones of the forearm *forwards* is an extremely rare event, for- merly supposed to be impossible without previous fracture of the olecranon, or extensive laceration of the soft parts. Modern observation, however, has shown the fallacy of this opinion, by adducing a number of unequivocal cases in which the displacement existed as a pure, uncomplicated affection. At least ten such examples are upon record, including one recently observed by Dr. Forbes, of this city, and another reported by Dr. R. P. Hunt, of Chicago. Of eight cases of forward luxation of both bones of the forearm col- lected by Streubel, six were unaccompanied by fracture of the olecranon. The manner in which the occurrence may happen is not well understood; but, from some experiments performed upon the dead subject, it would seem that if, while the forearm is powerfully flexed upon the arm, severe violence be applied directly to the olecranon and head of the radius, the articular surfaces of these bones may be thrown forwards from the condyles of the humerus with much greater facility than would at first sight appear possible. The accident is most common in young subjects under fifteen years of age, and must neces-

sarily be attended with extensive rupture of the ligaments, if not also with severe contusion and laceration of the other soft parts.

The signs are sufficiently characteristic. When the ulna and radius are thrown completely forwards, in front of the condyles of the humerus, the forearm will necessarily be considerably shortened, whereas, when they retain their relation with the condyles, it will be elongated to the full extent of the length of the olecranon. The forearm, moreover, is slightly flexed, but by a little effort it may readily be extended, or even bent somewhat backwards. The skin and muscles in front of the joint are in a state of tension ; the end of the humerus can easily be felt posteriorly, where it forms a large prominence, and there is a well-marked depression, a kind of vertical gutter, in the natural situation of the olecranon, bounded on each side by the margins of the trochlea.

Two methods of reduction may be employed for this dislocation ; one consists in flexing the forearm at a right angle with the elbow, and making extension by pulling the hand and wrist, while the heel is applied as a fulcrum to the lower third of the arm, the patient being under the influence of anaesthesia. Or, instead of this, the extending and counterextending forces may be applied to the hand and shoulder, the limb being in a straight position, and pressure made upon the ulna and radius by means of the thumbs. During the after-treatment, leeches and fomentations will probably be required, with proper support of the limb, until the parts have united. Passive motion must be commenced at an early period.

3. *Lateral* dislocation of the elbow-joint, besides being extremely rare, can hardly occur in any other than an incomplete form, and as a consequence of severe injury extensively implicating the soft parts. The most common cause of the accident is a fall upon the wrist or hand when the forearm is in a flexed and contorted state ; and the displacement will be so much the more likely to happen if, the moment the extremity strikes the surface, the arm is forcibly impelled sidewardly. It may also be produced by violence acting directly upon the forearm and arm in opposite directions, as when the former is driven inwards and the latter outwards. In a case mentioned by J. L. Petit the accident was occasioned by the limb becoming entangled in the spokes of a wheel. The displacement may be inwards or outwards, and is often associated with partial dislocation backwards.

In the dislocation *inwards*, fig. 664, there is great deformity at the ulnar side of the elbow, produced by the olecranon and head of the radius, the latter hitching against the inner condyle, while the outer condyle presents an unusual prominence immediately beneath

Fig. 664.   Fig. 665.

Lateral Dislocation Inwards.   Lateral Dislocation Outwards.

the integument at the external aspect of the joint ; the forearm is partially bent, and somewhat supinated ; and the muscles of the arm, both in front and behind, are dragged inwards by the displaced bones.

In the luxation *outwards*, fig. 665, the ulna rests upon the external condyle, while the inner condyle forms a sharp prominence on the inside of the elbow; the forearm is slightly bent and rigidly pronated; the motions of flexion and extension are much impeded; and the flexor and extensor muscles are in a painful state of tension. Both in this and in the inward displacement there is a remarkable increase in the breadth of the articulation, along with considerable flattening of its anterior surface, and a twisted condition of the forearm.

These luxations are easily reduced by extension and counterextension, performed in the usual manner, and by coaptation by pressing the bones in a direction opposite to that of their displacement. In general, the object may easily be attained by simply bending the elbow over the knee, as in the dislocation backwards. The after-treatment requires great care, both to prevent redisplacement and ankylosis.

The only instance of complete lateral dislocation of the elbow with which I am acquainted is one recorded by Nélaton. It was observed in a man, sixty years of age, who was admitted for another disease, the accident

having taken place twenty years previously, from a fall from a height of thirty feet. The elbow was much deformed and ankylosed.

4. Dislocation of the *ulna* alone directly *backwards* is an uncommon accident, and can scarcely be complete without fracture of the coronoid process. The signs are usually characteristic. The forearm and hand are slightly flexed, and inclined inwards as if they were twisted on their axis; the olecranon forms a prominent projection at the back part of the joint, as in fig. 666; and the head of the radius, although usually somewhat displaced, may be distinctly felt in its natural situation during the movements of flexion and extension, both of which, but particularly the latter, are very much restricted and painful. The accident generally arises from a severe fall upon the inner and upper part of the hand, suddenly and forcibly impelling the ulna upwards and backwards, away from the head

Fig. 666.

Dislocation of the Ulna Backwards.

of the radius, the coronoid process lodging in the sigmoid cavity of the humerus. Its most prominent features are the contorted state of the limb and the remarkable projection of the olecranon, which will always serve to distinguish it from other lesions. When the coronoid process is broken off, the posterior de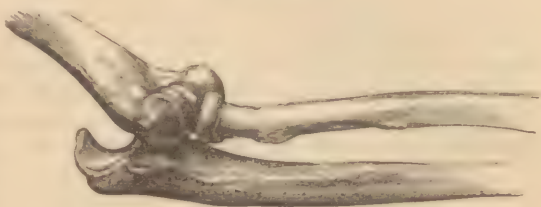formity will be unusually great, and, although it may be effaced by extension, yet the moment the arm is left to itself it returns.

The reduction is generally easily effected by bending the arm over the knee, and extending the hand and wrist. Coaptation may be aided, if necessary, by pressure upon the olecranon with the thumbs. When the accident is attended with fracture of the coronoid process, special retentive means will be necessary, of which the best is a rectangular tin, felt, or gutta-percha case, the limb being properly bandaged, and a compress firmly bound over the olecranon.

5. Finally, the bones of the forearm are occasionally dislocated simultaneously in *opposite directions*, the ulna being thrown backwards behind the humerus, and the radius forwards upon a plane with the external condyle. The accident is uncommon, altogether not more than five or six cases having been reported. It is produced by falls from a considerable height upon the hand, impelling the two bones with great violence at a moment when the forearm is considerably flexed and forcibly twisted upon its axis. It is readily recognized by the singular form of the elbow, which is sensibly shortened transversely, but much increased in its antero-posterior diameter; by the great prominence at the back of the limb, formed by the olecranon process; and by the remarkable inward contortion of the forearm and hand, which are both slightly bent. On attempting to flex the limb, the head of the radius is found to hitch against the humerus, and to offer an insurmountable barrier to further progress. The reduction of the ulna is readily effected by placing the knee in the bend of the arm, and then pulling the hand and wrist; but that of the radius is more difficult, and will require, in addition, pressure upon the dislocated head outwards and backwards.

Dislocations of the elbow-joint are occasionally complicated with injuries of the humerus and of the bones of the forearm, the former generally manifesting themselves in fracture of one or both condyles or of the inferior portion of the shaft of the bone, and the latter in fracture of the olecranon process, or the upper extremity of the radius or of the shaft of the ulna. Fracture of the coronoid process is very uncommon and is difficult of diagnosis; but may be supposed to exist when there is inordinate tendency to displacement of the affected joint. Crepitation is either absent or indistinct. Such complications demand the same kind of treatment, after the reduction of the luxation, as when they constitute independent lesions.

Compound dislocations of this joint are serious accidents, liable to be followed by the worst results, both immediate and consecutive. Such is the extent of the articulating surfaces that any considerable exposure by wound is extremely liable to cause ulceration of the cartilages and caries or necrosis of the bones requiring their eventual removal, or, what is worse, the sacrifice of the limb. The danger is materially increased when there is fracture with displacement, the end of one of the bones perhaps protruding in the form of a sharp spicule at the wound. Such cases will seldom do well if an attempt be made to replace and save the parts in the usual manner. The patient, if young and vigorous, may, it is true, occasionally progress favorably, but the chances are that the limb will, by

and by, have to come off, or that life will be brought into imminent danger by the pro-tracted suppuration, ulceration, and hectic irritation. When, therefore, the symptoms are at all unpromising—the joint being extensively opened, the muscles torn, and the bones seriously involved—the best plan, as a rule, is to amputate immediately, the moment reaction has occurred ; or, under more auspicious, but still trying, circumstances, to ex-cise the ends of the injured bones, placing them afterwards in such a position as to insure their speedy reunion, and, at the same time, in as good a one as possible for the future usefulness of the limb.

Congenital dislocation of the elbow is uncommon, and occurs only in a partial form. Most generally the displacement is limited to the head of the radius, which, forsaking the sigmoid cavity of the ulna, applies itself against the outer condyle. The movements of the elbow and forearm are restricted, but not annihilated ; and, as the head of the luxated bone always becomes remarkably elongated as the patient advances in years, reduction is only practicable in infancy and early childhood.

DISLOCATIONS OF THE SHOULDER.

Dislocations of the shoulder-joint are of very common occurrence, being, as stated else-where, more frequent than all the other dislocations together, a circumstance which is easily accounted for by the shallow condition of the glenoid cavity of the scapula, and by the extraordinary latitude of motion peculiar to this articulation. Moreover, there is in many persons, females and children especially, a remarkable tendency to relaxation of the ligaments and muscles of the shoulder-joint, which thus powerfully predisposes to luxation, the slightest accident being, when the parts are in this condition, often sufficient to produce it.

Experience has shown that dislocations of the shoulder are not nearly as frequent in women as in men ; for the reason simply that they are much less exposed than the other sex to the various exciting causes of these lesions.

Age exerts a material influence upon the production of these dislocations. The sta-tistics of Malgaigne and others prove that children under fifteen years rarely suffer from them. I have myself not witnessed such an accident before the age of twelve ; but Pro-fessor Ashhurst and Dr. John H. Packard, of this city, have each met with one in a child under three years, and Mr. Flower, of London, refers to one in an infant only fourteen days old, caused by a violent wrench of the arm. From fifteen to twenty-five the accident is also comparatively rare, but from this period on it becomes more common, and from forty to sixty it reaches its maximum. After sixty there is a marked decline in its fre-quency, and few cases are met with after seventy.

The nomenclature of these luxations has been much encumbered by distinctions and refinements, which, so far from simplifying the subject, only serve to embarrass it. There are, in fact, only four principal dislocations of the shoulder ; all the rest, concern-ing which so much has been written, are mere varieties, hardly entitled to separate consideration, as they differ merely in the degree of the displacement. These dislocations are the axillary, subcoracoid, thoracic, and subspinous. In the first, the head of the hu-merus, as the name implies, is situated in the axilla, under the glenoid cavity of the scap-ula ; in the second, a little below and to the inner side of the coracoid process ; in the third, beneath the clavicle, on the anterior and lateral aspect of the chest ; and in the fourth, on the posterior surface of the scapula, either immediately below the acromion process, or on the dorsum of that bone below its spine. The first two of these luxations are by far the most frequent ; the other two are, in fact, so uncommon that they may properly be classed among the rare luxations. Especially is this true of the subspinous variety, of which hardly a score of cases are upon record. To show its infrequency, I may state that of 105 cases of dislocations of the shoulder, analyzed by MacCormac, of London, only one was of the latter description. To these more common dislocations may be added, as so many varieties of displacements, those cases in which the head of the hu-merus has been found in the subscapular fossa, and above the coracoid process, as in a case observed by Malgaigne. The nomenclature here suggested, besides indicating the situation of the luxated bone, is in strict conformity with that of the dislocations of the hip-joint.

Not a little diversity of opinion has been expressed respecting the relative frequency of the axillary and subcoracoid luxations. I have myself always regarded the former as the more common ; but by Malgaigne and Flower the preponderance has been ascribed to the latter, and a number of recent writers have adopted this view. Flower basis his conclu-sions upon an examination of forty-one specimens in the different museums of London, of

which thirty-one are said to be unquestionably of the subcoracoid variety. He also states that at the time he published the results of his observations, he was cognizant of fifty recent cases of shoulder dislocations, of which forty-four were of this nature. If the diagnosis between these injuries during life could always be satisfactorily determined, one might feel inclined to adopt this view, but this, as is well known, is frequently impossible. Fortunately the matter is of little, if any, real practical value one way or another.

1. The *axillary dislocation*, a very common form of the accident, also known as the subglenoid luxation, is usually occasioned by violence applied to the elbow or hand, the limb at the time being elevated, and widely removed from the body. It may also be produced, when the arm is in this position, by a fall or blow upon the shoulder, acting directly upon the head of the humerus. I have met with five cases in which the accident was caused by muscular contraction. In four of the cases the luxation occurred in an attack of epilepsy, and in the other simply from raising the arm inadvertently above the level of the head. Dr. Garrison, of Illinois, met with an instance in which it was produced in a fit of sneezing. However induced, the head of the humerus will be found to be in the axilla, immediately beneath the glenoid cavity, lying upon the inferior border of the scapula, as in fig. 667, between the subscapular muscle and the long head of the triceps. The axillary vessels and nerves are somewhat compressed, the capsular ligament is largely opened below, and the articular muscles are nearly always more or less lacerated, if not partially separated from their attachments. The supraspinate and deltoid muscles, particularly the former, are violently stretched and spasmodically

Fig. 667.

Axillary Dislocation.

contracted; the broad dorsal and great pectoral, on the contrary, are usually somewhat relaxed.

The *symptoms* are, inordinate prominence of the acromion, as exhibited in fig. 668, which is much more sharp and distinct than natural, with a well-marked depression just below this process; flattening of the shoulder, and unusual fulness of the axilla, caused by the presence of the displaced bone, which, on motion of the limb, can easily be felt rolling about between the thumb and fingers, especially in lean subjects. The height of the axilla is at least an inch to an inch and a half greater than on the sound side. The elbow projects considerably from the trunk in consequence of the tension of the deltoid muscle, the forearm is slightly bent, the arm is perceptibly lengthened, the fingers are benumbed from compression of the axillary nerves, and the whole extremity, stiff and powerless, is generally somewhat supinated, although not necessarily so, as I have repeatedly seen it inclined in the opposite direction. Flexion of the forearm, also, is not an invariable occurrence; generally it is said to be so, but a number of cases have come under my observation in which the patient was able to extend and bend it at pleasure. When the biceps and triceps are put considerably upon the stretch, as when the head of the bone is thrown unusually far inwards, the limb often presents a singularly twisted appearance.

Although the signs of this dislo-

Fig. 668.

Axillary Dislocation.

cation are generally well marked, there are few accidents which are so liable to be mistaken, and no pains should, therefore, be spared to establish a correct diagnosis. The most reliable phenomena are, the flattening of the deltoid muscle, the prominence of the acromion process, the fulness and increased height of the axilla, and the peculiar projection of the elbow, which cannot be brought in contact with the side without strongly inclining the body outwards. The latter occurrence may be regarded as especially valuable, as there is no other lesion that simulates it. Another sign, first pointed out by Professor Dugas, of Georgia, is the inability which the patient experiences in touching the sound shoulder with the hand of the injured limb while the elbow rests in front of the chest.

2. In the *subcoracoid* dislocation, originally described by Malgaigne, the head of the humerus, instead of lying below the glenoid cavity of the scapula, rests in the armpit, immediately below and a little to the inner side of the coracoid process, as in fig. 669, under cover of the coraco-brachial and pectoral muscles. The symptoms which attend this form of displacement are very similar to those which characterize the axillary luxation; but the head of the humerus is not so distinctly outlined, and cannot always, especially in very muscular subjects, be readily perceived, unless the elbow is considerably elevated and rotated upon its axis. The arm is usually a little longer than naturally, but occasionally it is actually shorter. The motions of the joint are much impeded, and the hand cannot be placed upon the sound shoulder, while the elbow is held at the antero-lateral aspect of the chest. The hollow in the axilla is less than in the axillary displacement, and there is less compression of the brachial plexus of nerves. The limb is more or less twisted upon its axis, and the forearm is partially flexed.

Fig. 669.   Fig. 670.

Subcoracoid Dislocation.   Thoracic Dislocation.

3. The *thoracic dislocation*, the subclavicular of the French surgeons, is comparatively rare, and is by some surgeons regarded simply as an exaggerated variety of the subcoracoid luxation. It is usually caused by violence applied directly to the head of the humerus, or to the elbow, when the arm is elevated, and carried behind the central line of the body. The bone is thrust to the sternal side of the coracoid process, immediately below the clavicle, resting against the second and third ribs, under cover of the pectoral muscles, as exhibited in fig. 670. The anterior and inner parts of the capsular ligament are extensively ruptured, and there is usually considerable injury sustained by the adjoining muscles, especially the subscapular, the infraspinate, and the small teres, which are often severed from their attachments. In a case described by Malgaigne, the head of the bone lay immediately beneath the integument, in the interval between the deltoid and pectoral muscles.

The acromion process in this dislocation juts out with great distinctness, the depression beneath it being much more conspicuous than in the axillary variety of the accident, from the manner in which the deltoid muscle is drawn over towards the chest; and the head of the humerus is generally easily detected just below the clavicle, forming a hard prominence which readily obeys the movements of the limb. The elbow stands off widely from the body, in a backward direction, and the arm is commonly shortened from half an inch to an inch. The pain is less severe than in the dislocation downwards, as there is no compression of the axillary plexus, but the impairment of the functions of the joint are greater.

The most important diagnostic marks are, the peculiar attitude of the limb, the extraordinary prominence of the acromion, and the position of the head of the bone just below the clavicle, where it can generally be both seen and felt.

4. The *subspinous* dislocation, fig. 671, is so uncommon that it is very properly considered as one of the rare forms of injury of the shoulder-joint. It is generally produced by a fall upon the elbow or hand, the limb being at the moment raised, and stretched out in advance of the body, a movement which has the effect of depressing the head of the humerus, and of throwing it backwards upon the posterior surface of the scapula. The posterior superior part of the capsular ligament is extensively opened, and the articular muscles are not only stretched, but often severely lacerated, the subscapular being generally detached from the lesser tuberosity of the humerus. The head of the bone usually rests immediately beneath the posterior angle of the acromion, upon the back of the neck of the scapula, or upon the posterior border of the glenoid cavity. In rare cases only does it lie upon the dorsum of the scapula below the spine, as the term subspinous implies.

The *symptoms* are usually well marked. The rotundity of the shoulder is diminished, but not completely effaced, the acromion is abnormally distinct, and the head of the humerus may be both seen and felt in its new position, at the posterior part of the shoulder, below the spine of the scapula. The arm is considerably shorter

Fig. 671.

Subspinous Dislocation.

than natural, and the forearm, strongly rotated inwards, is bent obliquely across the chest. The axilla is deprived of its fulness, and, upon making firm pressure there, before there is any considerable swelling, the finger can be made to sink into the glenoid cavity. The arm cannot be supinated, and all attempts to move it are productive of severe pain, owing to the manner in which the head of the humerus is impacted in its new position.

General Diagnosis.—Although the diagnosis of dislocations of the shoulder-joint is usually sufficiently clear, cases occasionally occur in which quite the reverse is true. There are several accidents with which they are liable to be confounded, and from which it is of great importance they should be correctly distinguished. Thus, mere contusion of the deltoid muscle, or a sprain of the articulation, sometimes simulates to a very perplexing extent the symptoms of luxation, by causing more or less obliquity of position of the arm, with inability to raise it; hence the case is liable to be treated with improper severity, violent extension and counterextension being perhaps employed, when nothing but the most simple means are necessary. In general, however, the diagnosis is usually easily determined by a careful inspection of the affected joint. When there is no displacement, the head of the bone will, of course, be found to occupy its natural position, the shoulder retaining its rotundity, and the arm its natural length. Motion, too, will be found to be perfect if the patient be examined under the influence of anaesthesia.

Great perplexity will be likely to arise when there is a fracture of the acromion, the neck of the scapula, or of the superior extremity of the humerus; hence, whenever such an occurrence is suspected, the surgeon cannot possibly be too much upon the alert. In each of these accidents there are three circumstances which, if carefully considered, will always serve to prevent mistake. These are, preternatural mobility of the parts, crepitation, and facility of reduction, followed by an immediate recurrence of all the symptoms the moment the surgeon relinquishes his hold upon the limb. In dislocation, the head of the humerus is firmly fixed in its new situation, and is, consequently, moved with difficulty; there is complete absence of crepitation, or, if there be any noise, it is very faint, and entirely different from that which is caused by rubbing together the ends of a fracture; and, lastly, the restoration of the displaced bone can be effected only after much effort, generally, indeed, not without energetic extension and counterextension. Moreover, the reduction being once effected, the articular surfaces usually retain their natural relations, having no disposition again to separate.

In fracture of the acromion, the outer extremity of the bone is drawn down by the weight of the limb and by the action of the deltoid muscle, giving the shoulder a sunken appearance, and the arm is sensibly elongated and supported by the patient's hand. Restoration is readily effected by raising the elbow, but, upon abandoning it, there is an immediate reproduction of all the former symptoms, thus at once deciding the nature of the injury.

In fracture of the neck of the scapula, a very rare accident, the acromion retains its natural position, but is uncommonly prominent; the arm is elongated, and crepitation is easily elicited by raising the elbow, which will also have the effect of restoring the form of the joint.

The signs of fracture of the head and neck of the humerus are generally characteristic. The extremity of the bone, constituting the upper fragment, retains its natural position, while the rough, angular end of the shaft projects upwards and inwards into the axilla, being drawn thither by the pectoral and dorsal muscles. There is no displacement of the acromion, the shoulder is less flattened than in luxation, and the arm, instead of being elongated or of the natural length, is materially shortened.

Treatment.— Various methods may be employed for effecting the reduction of these different forms of dislocation; but the best of all, especially in the axillary, is to place a fulcrum in the armpit, upon the luxated bone, while extension is made upon the forearm, just above the wrist. The most efficient fulcrum for this purpose is the heel of the surgeon, divested of its boot, he and the patient lying in opposite directions upon a bed or

Fig. 672.

Reduction with the Heel in the Axilla.

table; and the efficiency of the operation will be materially increased, if, after the extension has been maintained for a little while, the limb is gradually brought forwards over the body, so as to raise the bone upwards and outwards to a level with the glenoid cavity. I sometimes find that I can reduce the dislocation more promptly and with less effort by sitting between the patient's limbs, with my own leg carried obliquely over the trunk, as this affords a much more powerful leverage than in the ordinary procedure. When unusual resistance is encountered, the extension should be aided by means of a stout fillet, secured around the lower part of the arm by the clove-hitch, and thrown across the surgeon's neck and shoulder, as seen in fig. 672.

Fig. 673.

Reduction with the Knee in the Axilla.

Dr. Garms, instead of placing the patient upon his back, makes him lie upon the abdomen. The two towels are fastened around the arm, one just above the elbow, the other a short distance below the shoulder. The latter is then given in charge of an assistant, standing on the affected side, to draw the arm laterally, while the operator, sitting on the floor, seizes the former, and, employing the heel in the usual manner, makes extension downwards and backwards. The operation is particularly applicable to the axillary form of the accident, and is so simple as not to require the aid of an anæsthetic.

Dr. Samuel Logan, of New Orleans, practises a method of reducing this dislocation, in which the surgeon, placing his legs nearly at a right angle with the patient's body, with a slight inclination upwards, plants the heel of one foot in the axilla, against the ribs, so

as to press a little crosswise, while the base of the great toe of the other foot rests against the acromion process. The trunk and shoulder being thus firmly steadied, the necessary traction is made upon the forearm, as in the ordinary method.

Occasionally the reduction is readily accomplished by making a fulcrum of the knee, as in fig. 673, the patient sitting up, and the surgeon supporting his foot upon the edge of his chair, or upon a stool. The operation is particularly applicable to dislocations in delicate females, and in old, emaciated subjects. It is performed by inserting the knee as high as possible in the axilla, and then, the top of the shoulder being thoroughly steadied with the hand, carrying the elbow forcibly downwards and inwards towards the side of the body. This procedure is characterized by great simplicity, but lacks the efficiency of that in which the heel is planted in the axilla.

A very simple method of reducing this dislocation, represented in fig. 674, was practised by Brunus in the thirteenth century, and by White, Mothe, Bell, Thompson, and others in the last. Revived by Rust, Kluge, Firz, and Malgaigne, it has been known to

Fig. 674.

Reduction by the Perpendicular Method.

succeed when other expedients have failed. In the original plan the patient lies upon his back, while the surgeon, standing behind him, raises the limb perpendicularly above the head, the shoulder being firmly fixed with one hand upon the acromion process, and the requisite extension made with the other, by grasping the arm above the elbow. The efficiency of this method will be greatly increased if, as suggested by Mr. George Lowe, the patient be placed in the sitting posture against a couch, sofa, or bedstead, the scapula steadied with the foot, the extension made at the wrist, and the humerus rotated upon its axis as the head of the bone approaches the glenoid cavity.

Mr. Kirby, of Dublin, was in the habit of reducing this luxation by a method somewhat more complicated than any of the preceding, but not less efficient. The patient being seated upon the floor, a stout fillet was secured around the lower part of the arm, and confided to an assistant, while another assistant, also seated upon the floor upon the opposite side, steadied the scapula by encircling the chest with his arms, his fingers being interlocked in the axilla. When these preliminaries were arranged, the assistants carried each one leg behind and the other in front of the patient, so as to rest the soles against each other. The limb being now elevated nearly to a right angle with the body, the extension was made in a slow and gradual manner, while the head of the bone was urged upwards towards the glenoid cavity, the elbow being at the same time raised and brought towards the side.

I have never had occasion to employ the pulleys in recent dislocations of the shoulder, and can hardly imagine that they could be necessary even in very stout, muscular subjects, as any surgeon may with a little patience and skill effect reduction by the methods now pointed out, with the aid of anæsthesia. If a resort to the pulleys, however, be demanded, they must be employed with great care, lest harm should befall the axillary vessels ; for the very fact that restoration cannot be accomplished by manual effort is an evidence of probable complication, and should be sufficient at least to put the surgeon on the alert. The operation is performed during the recumbency of the patient, or as he sits on his chair, as seen in fig. 675. The shoulder is firmly fixed by means of a long fold of muslin, the arm

Fig. 675.

Extension with the Pulleys.

being passed through a hole in the centre, and its ends held by assistants, or fastened to a staple in the wall. The extending band is tied around the lower part of the arm just above the elbow, and secured to the pulleys, which are then put in motion, the forces being applied transversely, and the head of the bone, as it approaches its socket, being lifted up by the hands in the axilla.

The reduction in the thoracic variety is easily effected by placing the heel in the axilla, so as to fix the scapula, and making the extension obliquely downwards and a little backwards, in the line of the displacement. The patient should lie upon the sound side, and as the head of the bone approaches the glenoid cavity it should be urged on by the pressure of the foot, at the same time that the arm is brought over to the body, very much as in the dislocation downwards. The chief impediments to the reduction are the two spinate muscles along with the deltoid.

The reduction of the subspinous dislocation is effected by making extension and counterextension in the usual way, and urging the head of the bone from behind forwards by

Fig. 676.

N. R. Smith's Method of Reducing Dislocations of the Shoulder-joint.

means of the hand, until it can be perceived in the axilla, when the restoration is completed by bringing the arm gently downwards and backwards, first into a line with the body, and then a little in advance of it. The principal obstacles to the replacement are the supraspinate, subscapular, large teres, and great pectoral muscles, which are generally powerfully stretched.

Professor N. R. Smith, of Baltimore, in 1831, recommended a very effective method for reducing dislocations of the shoulder-joint, which has often been successfully employed by other practitioners, especially by his old pupils. It simply consists in making the counterextension, as seen in fig. 676, from the opposite wrist. In this way the scapula is very firmly steadied, when all that is required is to depress the limb of the injured side and rotate it slightly upon its axis, the knee being pressed at the same time against the head of the humerus in the axilla.

Reduction by Manipulation.—The different forms of dislocation now described may all be reduced by mere manipulation, especially in recent cases, although I believe that the heel in the axilla is generally preferable to every other. In many instances simple torsion of the limb, particularly by rotation from without inwards, is quite sufficient for the purpose. The operation is performed by grasping the lower part of the forearm, and then turning the limb upon its axis, which has the effect of throwing the head of the humerus backwards and outwards, towards the glenoid cavity, when all that is necessary to induce it to slip into its proper position is to bring the limb on a line with the trunk. In this manner, I reduced in a few seconds, in 1869, after the failure of other means, an axillary dislocation of nearly three months' standing. Restoration is sometimes readily effected by simply lifting the limb obliquely across the chest, the scapula being well fixed at the moment.

Manipulation, as practised by Professor Henry H. Smith, of this city, consists, first, in elevating the arm and flexing the forearm; secondly, in rotating the head of the humerus upwards, outwards, and backwards, as far as possible, by using the forearm as a lever; and, lastly, in rotating the head of the bone strongly upwards and inwards by a reverse movement, while the elbow is brought to the side, the palm of the hand looking down, instead of up, as in the second stage of the proceeding.

When the head of the bone is thrown forwards upon the chest, it must, as a preliminary step, be forced down into the axilla, by carrying the elbow as far back as possible, and then elevating it, when, rotation being properly executed, it will readily slip into the glenoid cavity. In the posterior luxation, the same object is attained simply by raising the arm and carrying it strongly forwards.

The method of reducing dislocations of this joint by manipulation was warmly advocated, and rules laid down for its performance, by Sir Philip Crampton, as early as 1833, in a series of papers on the subject in the Dublin Medical Journal. In the luxation downwards he made gentle extension at the wrist, to secure a long lever, and then slowly raised the limb to nearly a horizontal position, so as to relax the flexor and extensor muscles. He then suddenly pushed the arm upwards and a little forwards, towards the patient's face, or, in other words, rotated it inwards with the hand turned prone, and at the same instant forced the trunk suddenly backwards with the left hand placed below the axilla.

In the luxation forwards, "the surgeon," says Crampton, "should place his left arm, extended horizontally, immediately below the walls of the axilla, between the dislocated arm and the chest, and then, grasping the wrist in his right hand, he should draw the arm forcibly across the patient's body."

In recent cases mere pressure with the fingers, as originally practised by Avicenna, afterwards by Desault, and lately again by Richet and Pitha, is often sufficient to effect the object even without the aid of an anæsthetic, particularly in the axillary variety of the accident. The patient being seated upon a chair, the surgeon, standing at his side, places one hand upon the acromion process of the scapula, and the other, with the fingers semiflexed, in the armpit upon the head of the humerus, while an assistant gently raises the affected arm, or the surgeon does this himself by letting the elbow rest upon his forearm. By pressure, steadily and persistently directed, the bone is gradually lifted over the rim of the glenoid cavity, its return being frequently accompanied by a distinct snap. The object will be greatly facilitated if the muscles of the arm and shoulder are perfectly relaxed, and if, as the head of the humerus approaches the glenoid cavity, the arm be slightly rotated upon its axis.

In the method recently suggested by Dr. Kuhn, of Elbeuf, the force is applied to the scapula while the humerus is the fixed point. A conical-shaped cushion being placed in the axilla with the apex directed upwards, the surgeon, standing at the patient's side, slightly lowers the arm, and presses it firmly against the cushion, so as to convert it into a lever of the first kind; then, grasping the inferior angle of the scapula with the other hand, he raises that bone and gives it a seesaw motion, which is speedily followed by a return of the articular surfaces to their natural relations. In the forward dislocation of

the humerus, the angle of the scapula is elevated and directed outwards; while in the backward luxation it is directed inwards. If any difficulty is experienced in effecting the reduction, the arm is confided to an assistant, but in general this is unnecessary, the manipulations of the surgeon alone being quite sufficient. Vincent, Skey, and others have occasionally succeeded in effecting reduction by placing a hard cylinder, as an iron knob, a porter-bottle, or a piece of wood into the axilla, and bending the arm over it across the chest.

Complicated Dislocations.—Luxation of the shoulder is sometimes complicated with fracture of the acromion, the neck of the scapula, or the superior extremity of the humerus. When this is the case, the rule is to reduce the dislocation, and then to set the fracture, the limb being put up temporarily in splints, as it will thus afford a better leverage for the management of the displaced bone. A fracture of the humerus in which this bone is severed at its surgical or anatomical neck is occasionally met with, and is a very serious occurrence, rendering the reduction one of extreme difficulty. In such a case our main reliance must necessarily be upon pressure, applied with the thumbs and fingers aided, perhaps, by fillets, while extension and counterextension are made in the usual manner. Displacement of the head of the humerus with fracture of the anatomical neck seldom admits of rectification in any case.

Compound dislocations of the shoulder-joint are rare in civil practice. When the head of the humerus is forced through the soft parts, no time should be lost in restoring it to its natural position, provided it has not sustained any serious detriment, when it should promptly be excised, so as to afford the patient a better chance of recovery.

Laceration of the axillary artery, followed by a diffused aneurism, sometimes complicates this accident. The prominent symptoms are, cessation of pulsation at the wrist, and the sudden formation of a large tumor in the axilla. The proper plan is at once to ligate the artery above and below the seat of rupture, and then to reduce the dislocation, provided it can be done safely. In a case related by Mr. Robert Adams, in which this was done, the patient made an excellent recovery. Dr. J. C. Warren was compelled to tie this vessel on account of an enormous aneurism, the result of injury inflicted by the surgeon's boot in an effort to effect replacement in a recent dislocation.

Anomalous Dislocations.—Malgaigne, in 1849, described, under the name of *supra-coracoid*, a luxation, at that time considered as unique, in a man, sixty-eight years of age, in which the head of the humerus was thrown forwards and upwards, above the coraco-acromial ligament, in contact with the inner border of the acromion. It rested upon the coracoid process, touched the lower surface of the clavicle, and formed a prominent projection immediately beneath the deltoid muscle. The arm was slightly shorter than natural. In a more recent case, under the care of Mr. T. Holmes, in a man, fifty years of age, who had fallen from a great height upon a heap of stones, the head of the bone had escaped from the glenoid cavity of the scapula, and lay upon the stump of the coracoid process, broken in the accident. It extended as high up as the clavicle and the coraco-acromial ligament, and, having passed through the fibres of the deltoid muscle, was covered merely by the skin. The long tendon of the biceps retained its attachment to the scapula, but was pushed to the outer side of the head of the humerus, which was twisted somewhat upon its axis. An example, apparently of a similar kind, has been recorded by Mr. Prescott Hewett.

Dr. Willard Parker, in 1852, met with a luxation of the shoulder-joint, in which the head of the humerus was thrown into the *subscapular fossa*, in a young man twenty years of age, whose right arm was caught between the belt and drum in a woolen factory, and violently rotated outwards, while the machinery was in rapid motion. When the limb was liberated, it was found lying diagonally across the body, in a state of strong, fixed pronation; the rotundity of the shoulder was lost; and the head of the bone could be distinctly felt beneath the scapula. The reduction was effected by carrying the arm outwards at a right angle with the body, and then pulling the hand and wrist, so as to force the humerus into the axilla, whence it was afterwards easily raised into its proper situation.

In a dissecting-room specimen, fig. 677, in my cabinet, the head of the humerus is thrown forwards, and lodged under cover of, and partly above, the clavicle, in contact with the costal surface of the scapula. The accident was accompanied by a fracture of the coracoid process, which is hooked over the head of the humerus. The shoulder was permanently ankylosed, and the arm hung stiffly along the side of the chest.

Larrey has described a preparation, in which the head of the humerus had penetrated the chest, through the third intercostal space, so as to form a tumor within its cavity.

The accident was produced by a fall upon the elbow, separated at the moment from the side of the body.

In a case reported by Laugier, the bone was turned directly forwards, resting against the outer margin of the coracoid process. The great tuberosity corresponded to the glenoid cavity, and the limb had a remarkably twisted appearance.

The reduction in these anomalous dislocations is effected upon the same principles as in the more ordinary forms of the accident. As there is usually extensive laceration of the soft parts, the operation is generally a very easy one, although it may be very difficult to keep the head of the bone in place, especially when the accident is associated with fracture of the coracoid process or the glenoid cavity of the scapula. In a case of dislocation of the head of the humerus against the coracoid process, of eleven weeks' duration, in a man, thirty-two years of age, Professor T. G. Richardson promptly effected reduction by raising the limb perpendicularly on a line parallel with the body while he steadied the acromion process with his foot. Having maintained this position for a few minutes, the arm was brought quickly down over an assistant's hand placed as a fulcrum in the axilla.

Double Dislocations.—Finally, there is occasionally a simultaneous dislocation of both shoulder-joints. Such an accident, however, of which interesting cases have been reported by W. H. Van Buren, Geddings, Cowper, T. W. Grosvenor, and others, is exceedingly uncommon. The head of each bone is generally forced down into the axilla, or one occupies this situation and the other the chest beneath the pectoral muscles. The dislocations which are sometimes complicated with fracture of the scapula, humerus, or clavicle, are usually caused by a fall, in which the person stretches out both hands to save himself from injury. In a case treated by Ballingall, the accident occurred during an epileptic fit; and in another, recorded by Nathan Smith, in an attack of puerperal convulsions. I am cognizant

Fig. 677.

Anomalous Dislocation of the Shoulder-joint.

of two cases of simultaneous dislocation of the shoulder-joint, one of them having occurred in my own practice, in which the head of the humerus was thrown into the axilla in attacks of epilepsy.

The reduction in the double dislocation is effected upon the same general principles as in the single variety. In Smith's case, replacement was effected at the end of seven months. In a case recorded by Fischer, the patient, a stout, athletic man, restored the parts by his own efforts. Seating himself upon a high bench, he seized, simultaneously with both hands, a transverse beam above his head, and, throwing himself suddenly and forcibly from his seat, both bones instantly slipped into the glenoid cavities with a crackling noise. In Van Buren's case, the man died in five hours after the accident, from injury of the skull and brain.

After-treatment.—The after-treatment of dislocations of the shoulder requires special attention. In the first place, it is highly important to guard against a recurrence of the accident, which is so liable to happen after all injuries of this kind, especially after luxation into the axilla. Generally, all that is necessary for this purpose is to support the elbow, forearm, and hand for some time in a sling close to the side of the body; or, if the patient be restive, the arm may be secured to the trunk, over a small pad, by six or eight turns of a bandage. Full elevation, abduction, and rotation of the limb should not be permitted for five or six weeks, or until there is reason to believe that the capsular ligament and muscles have been in great degree repaired. Inflammation is treated upon ordinary principles.
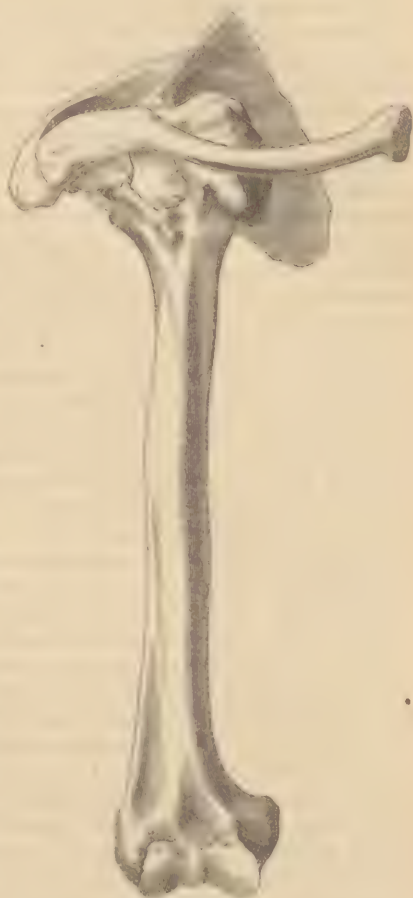
Dislocations of the shoulder are particularly liable to be followed, despite the best directed efforts of the surgeon, by atrophy of the deltoid muscle and by more or less permanent rigidity of the articulation. To counteract these occurrences, passive motion should be instituted as early as possible after the receipt of the injury, and perseveringly continued until the parts are completely restored to their normal condition. When, as occasionally happens, the rigidity is dependent upon contraction of the neighboring muscles, especially the great pectoral and broad dorsal, it may be promptly overcome by the free subcutaneous division of the resisting fibres with the tenotome. The atrophy of the deltoid may sometimes be relieved by electricity and by frictions with veratria liniment.

One of the most disagreeable and perplexing occurrences after the reduction of a dislocation of the shoulder is the difficulty of keeping the parts in their natural relations. This circumstance may be due to several causes, the most frequent of which are, fracture of the margins of the glenoid cavity, and the rupture of some of the muscles of the joint, in consequence of which the head of the humerus, the moment it is left to itself, falls away from the scapula into some abnormal situation, generally down into the axilla, by the mere force of the weight of the arm. Such an event is always very annoying, inasmuch as it is apt to induce the belief, on the part of the patient and his friends, that the reduction was not perfectly effected. The best remedies are rest and proper support of the affected parts, followed, in due time, by passive motion and other means for combating rigidity and ankylosis.

Accidents.—Dislocations of the shoulder are sometimes followed by paralysis of the deltoid muscle, from injury done to the circumflex nerve by the head of the humerus. Occasionally the axillary plexus suffers very seriously, and then the paralysis may be much more extensive, involving, perhaps, the whole arm, as in two cases reported by Professor Dugas. When the lesion is slight, it may disappear spontaneously, or with the aid of stimulating liniments, veratria ointment, and counterirritation, especially vesication; but in its more severe forms, as when it depends upon contusion and partial disorganization of the nerves, it often proves very refractory, and may even be incurable.

Another unpleasant effect which now and then succeeds dislocations of the shoulder, is œdema of the corresponding extremity, arising from the pressure of the head of the humerus upon the axillary veins and lymphatics; this, however, rarely lasts beyond a few days, and generally disappears spontaneously or under very simple means.

A sudden development of emphysema, first noticed by Desault, is sometimes met with after this accident, and is well calculated to create unpleasant apprehensions in the mind of the attendant. It is evidently caused by a wound of the chest, from fracture of a rib, penetrating the pleura and lung, as is proved by the fact that the starting point of the air is always under the pectoral muscle, from which it rapidly spreads to the axilla and to other parts. It may readily be distinguished from an extravasation of blood, consequent upon rupture of the axillary artery, by its elasticity, by the continuance of the pulse at the wrist, by the natural appearance of the skin, and by the production of a crackling noise when the part is pressed with the finger. Astringent lotions and gentle compression are the proper remedies.

Finally, the accident is sometimes attended with rupture of the axillary artery, leading to copious infiltration of blood, or, when the lesion affects only the inner tunics of the vessel, to the formation of a false aneurism. In the former case, the proper treatment is ligation of both ends of the vessel; in the latter, of which a remarkable instance has been recorded by Nélaton, after the reduction of the luxation, the subclavian artery should be tied. In an instance of subcoracoid dislocation observed by Bérard, in which there was no pulsation at the wrist after the accident, several of the fingers were attacked with gangrene, followed by the death of the patient. The internal coats of the axillary artery were torn across in their entire circumference, and the outer one greatly stretched.

Old Dislocations.—Old dislocations of the shoulder are often brought under the notice of the surgeon, and the question, therefore, arises, at what period after their occurrence should he refrain from an attempt at reduction? Upon this subject I do not think it possible to lay down any definite rules. I have myself been foiled at the end of the sixth week, and have known other practitioners of great skill and experience to be equally unfortunate. On the other hand, I succeeded in one case at the end of the seventy-second day, and in another at the expiration of the third month. Physick succeeded in a number of instances after two and three months; and examples of from four to seven months' standing have been reported by McKenzie and Jameson, of Baltimore, Dorsey and Gibson, of this city, and by other American surgeons. Dr. Nathan Smith effected reduction in one case nearly one year after the occurrence of the accident. Keppell is

said to have succeeded at the end of fourteen months, and Dieffenbach at twenty-four, not, however, without the extensive division of the capsular ligament and adjoining muscles. These instances are certainly very encouraging, but they should, nevertheless, be received with great caution, especially when it becomes necessary to view them as examples for our imitation. It should not be forgotten, as stated elsewhere, that the greatest possible differences prevail in regard to this subject; that in one case a dislocation may become irreducible in several weeks, and in another not under several months, depending upon the individual circumstances of each.

Perhaps the best plan that can be adopted in these chronic cases is to be guided by the degree of motion that has been acquired by the luxated bone. When this is considerable, it may be assumed that it has succeeded in establishing for itself a new joint, which it might be dangerous to disturb on account of its important relations with the surrounding parts. Another consideration which should have its weight is the amount of inflammation by which they are followed; if this has been unusually violent, it may be inferred that there has been copious plastic effusion, filling up the original socket, and causing extensive adhesions among the muscles and vessels, matting them firmly together, and rendering interference hazardous. Interference would also be particularly dangerous in subjects laboring under atheromatous degeneration of the arteries.

When it is deemed advisable to attempt reduction, a certain amount of preliminary treatment should always be instituted, with a view of facilitating the breaking up of the abnormal adhesions between the head of the displaced bone and the surrounding parts, so as to lessen the danger both of failure and of injury to the axillary vessels and nerves, after the application of the extending and counterextending forces. The method of reduction by traction upwards, generally known as that of Moth, is to be especially avoided, as it is more liable to be followed by laceration of the axillary artery than the more common procedures.

Manipulation is beyond question the safest mode of procedure in neglected dislocations of the shoulder, especially when the parts have not remained out of place longer than five, eight, or ten weeks. A good plan, one that has often succeeded under such circumstances, is, after the adhesions have been broken up by rotation and circumduction, to extend the limb at a right angle with the chest, while the trunk is steadied with a sheet, and then bringing the elbow suddenly and forcibly to the side of the body, over the arm of the surgeon placed near the axilla. During this manipulation, the head of the bone, if not too strongly impacted, slips readily into the glenoid cavity of the scapula. The employment of pulleys in such cases is generally worse than useless, while that of Jarvis's apparatus is fraught with danger to limb and life.

Notwithstanding the greatest care that can be exercised in these operations, the issue is occasionally most disastrous. The accidents that are most liable to occur are, severe contusion of the soft parts, fracture of the humerus, and laceration of the axillary artery. A number of instances have been related in which death was produced either by shock or by the severity of the resulting inflammation.

The skin and muscles must often, of necessity, be much bruised, and the latter sometimes even partially lacerated, in these operations. The occurrence may be brought about simply by the long-continued pressure of the heel in the axilla, or by the use of special apparatus, and is not unfrequently attended with extensive abrasions of the surface and more or less infiltration of blood in the connective tissue of the axilla and side of the chest. Occasionally large abscesses form in and around the joint.

The axillary artery has been ruptured in a considerable number of instances, and the result, in nearly all, has been promptly fatal. The disastrous cases recorded by Verduc, Petit, Leder, Delpech, Cooper, Pelletan, David, Flaubert, Bell, Gibson, Blackman, Lister, and others are well known to surgeons, and should serve as warnings in regard to rude and protracted interference in accidents of this kind, sometimes even when they are not of long standing. That such an occurrence should happen is not at all singular when it is recollected how liable dislocations of the shoulder are to be followed by severe inflammation and copious deposit of lymph, firmly gluing the axillary artery to the surrounding parts, and thus necessarily endangering it in any forcible attempts that may afterwards be employed to restore the head of the humerus to its natural position. The necessary result of such an injury is, of course, an aneurism, generally of a diffused nature, and characterized by the ordinary phenomena, as the sudden formation of a tumor in the axilla, and the cessation of pulsation at the wrist.

The circumscribed form of aneurism is uncommon as an effect of this accident. Two typical cases of it have been recorded by Dupuytren and Nélaton, in each of which a con-

siderable period elapsed before the tumor attained much bulk. In the former the swelling was mistaken for an abscess, which was opened by mistake, and followed by fatal hemorrhage. In the other case, that of an old woman who had a subglenoid luxation that was easily reduced, the subclavian artery was ligatured.

The axillary vein has sometimes been lacerated. Froriep has related an instance of this kind in a woman twenty-six years old. The axilla became suddenly enormously distended with blood, and death occurred within an hour and a half. The dislocation had existed only twenty days. Professor Agnew, of this city, has reported a similar case as having occurred in a woman sixty years of age. The dislocation had existed only six weeks. Perfect recovery ensued.

Of 19 cases of rupture of the axillary artery, in efforts to reduce old luxations of the shoulder-joint, analyzed in 1873, by Dr. Willard, of this city, 12 proved fatal, 6 recovered, and of 1 the result is not known. In 3 of these cases, the axillary artery was tied, in all without benefit; and the subclavian in 4, with 2 recoveries. Rupture of the axillary vein and artery together happened in 3 cases, 2 of which ended unfavorably, the result of the other not being stated.

A number of instances of laceration of the axillary nerves have been reported as having occurred in attempts to reduce old dislocations of the shoulder. The accident is necessarily followed by more or less paralysis of the superior extremity. A more common effect is severe contusion of these cords, with pain and œdema of the limb, and temporary impairment of function.

Fracture of the humerus has occurred in the hands of some of the most distinguished surgeons. The portion most liable to give way is the surgical neck, and the accident always happens during the violent efforts that are made to force the head of the bone out of its abnormal position while the arm is pressed forcibly across the chest, the strain thus produced being concentrated at the superior extremity of the humerus. The event is generally indicated by a loud noise or snap.

It is not improbable that in a very old person the ribs might be fractured in efforts of this description by the pressure of the heel in the axilla or by the use of Jarvis's adjuster. One such case was recently reported by Mr. Teevan, of London.

The immediate effects of such accidents, especially of rupture of the axillary artery and vein, either singly or conjointly, are generally followed by excessive prostration, deadly pallor of the countenance, clammy sweats, feeble respiration, and cessation of the pulse at the wrist. To meet such contingencies powerful stimulants and even the use of the electric battery may be necessary. When the axillary artery is ruptured, the most correct plan is at once to expose it by a free incision, and to ligate it at each extremity, as in aneurism of a similar nature in other parts of the body. When the tumor is circumscribed, and of slow formation, ligation of the subclavian artery, as practised by Gibson, Warren, and Nélaton, would be proper. Large extravasations of blood in the armpit even if produced by rupture of the axillary vein, generally readily disappear under the influence of sorbefacient remedies, especially strong solutions of chloride of ammonium.

The constant and excessive suffering which sometimes attend an unreducible dislocation of the shoulder-joint, from the pressure of the humerus upon the brachial plexus of nerves, can only be relieved by the excision of the head of the bone; an operation which, so far as I know, was first performed in 1860 by Professor Edward Warren, formerly of Baltimore, now of Paris. His patient was a female, fifty years of age, who, twelve months previously, in a fall, had luxated the humerus, throwing it down into the axilla beneath the coracoid process in contact with the brachial plexus of nerves, occasioning violent and persistent pain, with great debility and gradual emaciation. The joint was exposed by a V-shaped incision, and the head of the bone, firmly wedged in its new position, divided through the surgical neck. The patient rapidly recovered with a good use of the arm. The precedent set in this case has been followed by other surgeons, as the only operation that holds out any chance of relief from the frightful suffering entailed by such an accident. When the head of the humerus is so firmly fixed in its acquired position as to render the corresponding limb completely useless, the most rational plan is to divide the bone subcutaneously through its neck, with a view of establishing an artificial joint. This can be readily done by means of an Adams's saw, with the precaution of avoiding the brachial artery and axillary plexus of nerves. In a case of luxation of the shoulder-joint of fourteen months' duration in a man thirty-eight years of age, Dr. J. Ewing Mears, in 1875, performed an operation of this kind with very gratifying results, the patient, when last seen, nine months thereafter, having an excellent use of his limb. Passive motion, long continued, after all such pro-

cedures, is an indispensable condition of the treatment. When the operation fails excision of the head of the bone is the only resource.

Congenital Dislocations.—Congenital dislocations of the shoulder-joint have been particularly studied by Mr. Robert W. Smith, who directed special attention to them in his excellent work on fractures published in 1847. Since then they have been examined with much care by Gaillard, Guérin, Nélaton, and others.

The malposition, which may be single or double, sometimes coexists with similar displacement in other articulations. Only two varieties have hitherto been recognized by dissection, termed, by Mr. Smith, the subcoracoid and the subacromial, the head of the humerus in the former being lodged beneath the coracoid process, and in the latter on the dorsal surface of the scapula, below the outer and posterior part of the acromion. The latter might, perhaps, more properly be called the infraspinous form of the luxation.

The symptoms of both these dislocations are well marked. In the subcoracoid variety, the shoulder has a flattened appearance, especially at its upper and posterior aspect, the acromion is unnaturally sharp and prominent, there is a remarkable hollow in the supraspinous fossa, and the head of the humerus may readily be felt beneath the coracoid process, forming a distinct ball, which promptly obeys the movements of the elbow. The arm, which hangs along the side, is greatly withered, thus singularly contrasting with the forearm and hand, which generally retain their full development, being in fact quite as well conditioned as those of the opposite limb. The movements of the scapula are perfectly normal, while those of the arm are either annulled, or very much impeded, especially abduction; the forearm can be bent, but not actively extended. The movements, on the contrary, of the hand and fingers, are nearly, if not entirely, natural.

In the subacromial dislocation the head of the humerus may easily be felt on the dorsum of the scapula, a short distance below the root of the acromion, where it forms a distinct, unmistakable prominence. The deltoid muscle is flattened externally and in front; the acromion is uncommonly salient; the arm, shortened and withered, is rotated inwards towards the trunk; and the forearm and hand are slightly pronated, supination being executed with great difficulty.

Dr. Rodrigue, of Pennsylvania, has reported an instance of intrauterine dislocation of the shoulder-joint complicated with fracture of both bones of the forearm, caused by a fall of the mother near the middle term of pregnancy. The head of the humerus lay in the axilla, and could not be restored to its normal position.

The treatment of these dislocations must be conducted according to the general principles laid down in a previous page. In a remarkable instance, Gaillard succeeded in effecting the reduction of a congenital luxation of the shoulder-joint in a girl sixteen years of age, who recovered with a most excellent use of the arm. For several weeks prior to the operation, the parts were daily subjected to passive motion and manipulation, so as to induce them to yield the more readily to the necessary extension and counterextension. The inflammatory symptoms that followed the reduction were combated by the usual means.

Dislocation of the Tendon of the Biceps.—The tendon of this muscle is liable to be dislodged, by being violently wrenched from its bed in the humerus, and, perhaps, partially torn, if not completely snapped asunder. In the latter case, the upper extremity of the tendon may float loosely about within the joint. The accident generally happens from falls or blows upon the shoulder, forcing the humerus away from the glenoid cavity of the scapula, generally upwards and inwards against the coracoid process, or forwards against the ribs. It may also occur from

Fig. 678.

Dislocation of the Tendon of the Biceps Muscle.

falls on the hand or elbow, especially if, at the moment, the limb is very much twisted upon its axis. The nature of the lesion is always obscure, and, therefore, very apt to be overlooked or to be mistaken for fracture, sprain, or dislocation of the shoulder. The most reliable symptoms are, inability to flex the arm from the loss of power in the biceps, and pain at the seat of the injury, either alone, or in conjunction with more or less prominence of the head of the humerus. Reduction should be attempted by thorough

relaxation of the affected muscle by bending the forearm at a right angle with the elbow, and then pressing the tendon back into its proper place with the fingers. The after-treatment should be strictly antiphlogistic, otherwise there will be great danger of permanent ankylosis of the joint. If the tendon is completely severed, the limb will always be weak. In the adjoining drawing, fig. 678, from a preparation of Mr. Sodon, the tendon of the muscle lay with its sheath on the lesser tubercle of the humerus.

3. INFERIOR EXTREMITY.

DISLOCATIONS OF THE FOOT.

Luxations of the *phalangeal* and *metatarso-phalangeal* joints are uncommon, and are mostly of so complicated a character as to require amputation. The reduction is always easy.

Of dislocation of the *great toe* at the metatarsal joint, a very infrequent accident, I have seen two cases, one recent and the other old. The following is a brief history of them.

A gentleman, forty-two years of age, struck the dorsal surface of the foot against a lump of coal, bending the great toe downwards and dislocating it at the metatarso-phalangeal articulation. The accident, which caused considerable pain, was so well marked as to be at once recognized. The toe, inclined somewhat outwards, lay a little higher than in the natural state, and was fully half an inch shorter than the sound one. The head of the first phalanx rested upon the dorsal surface of the anterior extremity of the metatarsal bone, where it formed an abrupt, well-defined prominence. The projection on the plantar surface, formed by the head of the metatarsal bone, was less conspicuous. The adductor muscles of the great toe formed a broad, tense cord at the inner side of the foot. I saw the man within an hour after the accident, before there was any swelling or discoloration of the parts; and having placed him under chloroform, I readily drew the toe into its proper position with the aid of a narrow roller secured with a clove-hitch knot, the extension being made forwards and slightly downwards, to disengage the head of the phalanx from the anterior extremity of the metatarsal bone. The foot was steadied by an assistant grasping the ankle.

In the other case the foot was caught between two steamers, which twisted off the man's boot, severely wrenching the limb, and bruising the soft parts. The phalanx of the big toe was forced below the metatarsal bone, forming a large prominence in the sole of the foot, which has ever since, now a period of six years, been a source of much annoyance, being frequently so sore and tender as to interfere materially with progression. In such a case resection or amputation would be the proper remedy.

The reduction of this luxation is occasionally attended with considerable difficulty, depending probably upon the manner in which the adductor muscle and the sesamoid bones are dragged by the displaced phalanx backwards over the extremity of the metatarsal bone. In the event of such a contingency an attempt might be made to effect restoration by means of Dr. Crosby's plan of reducing dislocations of the thumb, raising the toe perpendicularly, and then applying strong pressure against its base, so as to push it from behind forwards, and from above downwards.

An instance, so far as I know a solitary one, of dislocation of all the toes from the metatarsal bones, has been recorded by Josse, of Amiens, the patient being a dragoon who, in a fall from his horse, struck his foot against the ground, forcing the bones outwards. The reduction could only be effected after the removal of the head of the first metatarsal bone, which projected through a wound in the skin.

The *metatarsal* bones are rarely dislocated, owing to the firmness of their connections with each other and with the lower row of tarsal bones. The accident is most commonly compound. A simple luxation, however, of one or more of these bones, is sometimes occasioned by a violent wrench of the foot, or by the passage of the wheel of a carriage, as happened to me in a case, many years ago, in which the fourth and fifth metatarsal bones were detached from their connections with the cuboid bone, and thrown upwards upon the tarsus. The reduction was effected with great facility, and, under the employment of leeches and other antiphlogistics, the man was able in the course of a fortnight to exercise on crutches, regaining eventually a good use of his limb.

The only case of a complete dislocation of all the metatarsal from the tarsal bones of which I have any knowledge, was communicated to me by Dr. Traill Green, of Easton, Pennsylvania, as having occurred under his observation and that of Dr. Edward Swift. The patient, a man, sixty-five years old, in falling down a flight of stairs, injured the

left foot, which was found soon after the accident to be much swollen over the arch and very painful, with deformity at the inner and outer edge. The metatarsal bone of the great toe was separated from the internal cuneiform bone, and thrown over towards the outer margin of the foot, leaving the latter bone quite prominent at the inner side. A similar condition existed on the opposite side, the metatarsal bone of the little toe being thrown off completely from the cuboid bone, so as to present a well-marked projection at the outer border of the foot. In short, the twisted state of the foot, the great deformity, and the swelling of the arch, clearly indicated a lateral displacement of all the metatarsal bones.

The reduction was easily effected. The patient being placed in a half-reclining posture on a settee, with his right foot against the arm, to brace himself during the operation, an assistant applied his knee to the instep, and while he made extension by grasping the dislocated portion of the foot, previously surrounded by a wet roller, to prevent the lac from slipping, Dr. Green, who supported the leg upon his thigh, made strong lateral pressure, in a direction contrary to that of the displacement. The parts soon began to yield, and in a few minutes returned to their proper place with a distinct snap, all deformity at the same time disappearing.

Dislocation of the *tarsal* joints is uncommon, their limited motion and the strength of their ligaments forming so many obstacles to their disunion. The astragalus is almost the only bone which is liable to displacement, and this accident is also unusual.

Dislocation of the *cuneiform* bones is extremely infrequent. The internal one is most liable to suffer. The accident, of which a well-marked case has been reported by Dr. Vedder, of Elmira, New York, is usually caused by falls from a considerable height, in which the person alights upon the sole of the foot, the force separating the bone from its natural relations. A projection on the inside of the foot, and a slight elevation of the bone, from the action of the anterior tibial muscle, are the characteristic signs of the lesion. The reduction, which is difficult, is effected mainly by pressure. In two cases of this luxation, mentioned by Sir Astley Cooper, replacement was found to be impracticable. When this happens, the patient, notwithstanding, generally, in time, regains a tolerably good use of the limb.

Retention is maintained by adhesive strips, a compress, and bandage, aided by splints, to keep the foot in a quiet, easy position. When the inflammation has sufficiently subsided, a leather strap with a soft pad should be worn, to protect the parts until the reparative process is completed.

The *scaphoid* and *cuboid* bones are occasionally separated from their connections with the astragalus and calcaneum, in consequence of the falling of a heavy weight, or of a person jumping from a considerable height and alighting upon the sole of the foot. Under these circumstances the foot is shortened, and twisted upwards and inwards, forming a remarkable prominence upon the instep, which gives it a distorted appearance not unlike what occurs in varus. The accident, which is extremely infrequent, is easily remedied by fixing the leg and heel, and then drawing the toes outwards, in a direction contrary to that of the displacement. Suitable retentive means will be required to prevent a recurrence of the luxation.

The *calcaneum* may be dislocated from the cuboid bone laterally, in an outward direction, by causes similar to those producing displacement of the other tarsal bones. The accident is easily detected and remedied by manipulation.

A remarkable instance of dislocation of the five anterior *tarsal* bones from the astragalus and calcaneum has been recorded by Sir Astley Cooper, as having occurred in a laboring man, from the fall of a very heavy stone. The foot was singularly distorted, exhibiting very much the appearance of clubfoot, the forepart being turned inwards upon the astragalus and calcaneum, so as to give the limb an arched shape. The reduction was easily effected by fixing the leg and heel, and pushing the luxated bones in a direction contrary to that of their displacement. A similar case has been recorded by Petit.

Dislocations of the *astragalus* occur under two varieties of form, the partial and the complete; in the former, as the name implies, the bone still retains some of its connections with the tibia and fibula, or the calcaneum and scaphoid, whereas in the latter the connections are entirely lost, complete disruption having taken place, or, in other words, the bone is lifted bodily out of its original position into one altogether new. It is obvious that such an accident can only occur from the application of excessive violence, in which the foot is strongly extended upon the leg, and more or less rotated upon its axis. Hence it is always of a grave nature, and rarely unaccompanied by fracture of the

inferior extremity of the tibia and fibula, which thus adds still further to its complications and dangers. Occasionally, indeed, the astragalus itself is severely shattered.

Dislocation of the astragalus may take place in two directions, backwards and forwards, the latter, which is by far the more frequent, admitting also of a certain degree of displacement laterally, or to either side, in consequence of a twist of the foot. In the posterior luxation the bone does not experience any rotation, and is, therefore, more in the course of the median line, suffering no material lateral deviation. Authors describe two lateral dislocations of the astragalus, but such a displacement can, for obvious reasons, occur only in connection with fracture of the tibia and fibula, or of both these bones.

In the luxation *backwards*, of which only a few cases have been reported, the astragalus is thrown behind the ankle, resting upon the superior surface of the calcaneum, where it forms a large, characteristic prominence. The tendo Achillis is pressed strongly backwards by the displaced bone, there is great tension of the skin of the heel, the muscles of the calf are very rigid, the tibia is slightly pushed forwards, and the instep appears a little shorter than natural. In general, also, there is a slight vacuity in front of the joint. Both the tibia and fibula are sometimes fractured.

The reduction is attended with extreme difficulty, owing to the manner in which the surfaces of the astragalus and calcaneum are interlocked with each other, and I am not aware that the operation has ever succeeded, except in one case, which occurred to Mr. Liston, and in which the accident was attended with fracture of the tibia and fibula, which had probably the effect of rendering the parts more movable. In attempting to replace the bone, the leg and foot should be as strongly flexed as possible, so as to induce thorough relaxation of the gastrocnemial muscles, and then, while extension and counter-extension are made by means of the clove-hitch, the astragalus should be urged from behind forwards into its natural position. When the difficulty is very great, the parts absolutely refusing to yield to any efforts, however judiciously applied, the only thing to be done is the subcutaneous section of the tendo Achillis; an operation which has occasionally proved successful.

When reduction fails, the patient will in time acquire a tolerably good use of his limb, the parts accommodating themselves gradually to their new relations. In one instance, where the attempts proved unsuccessful, the bone caused sloughing of the soft structures, and was obliged to be extracted.

The luxation *forwards* is generally incomplete, the anterior half of the bone, or a little more, resting upon the dorsal surface of the scaphoid bone, while the posterior half is imbedded in the hollow between the two articulating surfaces of the calcaneum. The displaced bone forms a distinct prominence over the instep, while a marked vacuity exists at the inner part of the foot, just below the corresponding malleolus. The tibia and fibula either retain their natural position, lying upon the posterior surface of the astragalus, or, as more commonly happens, they are carried slightly forwards, thus increasing the length of the heel, and inclining the foot towards one side or the other, according to the peculiar relations which the bone may sustain towards the calcaneum, a trifling change of position being capable of determining the nature of the lateral displacement.

In the complete form of the accident, the bone is forced away entirely from its natural position, being tilted up in front of the joint so as to rest upon the scaphoid and cuneiform bones. The signs are characteristic, the large prominence at the instep, the constrained and twisted position of the foot, the shortening of the leg, and the descent of the malleoli towards the sole of the foot, together with the elevation and lengthening of the heel, being sufficient to reveal its nature at a glance.

Sometimes the position of the astragalus is almost completely reversed, and there are few cases in which the displacement is unattended with fracture of the tibia and fibula, or even of the astragalus itself. Moreover, the dislocation is not unfrequently compound, the soft parts being severely lacerated, and the wound extending into the ankle and tarsal joints; or, when such an effect has not been the direct result of the accident, the foot is soon reduced to that condition by the ulceration and sloughing caused by the pressure of the displaced bone upon the integument of the instep.

The great obstacle to reduction in this as in the backward dislocation is the malposition of the astragalus, or the change in its axis, which not unfrequently baffles all the efforts of the surgeon at restoration, however well directed or perseveringly continued. Even when the displacement is only partial, the difficulty will generally be very great, although less than in the complete form, in which it is usually insurmountable. In the latter case, indeed, it is questionable whether, after what experience has taught us, it would be judicious to make any efforts at reposition, seeing how much all such trials,

rough and protracted as they necessarily must be, must tend to aggravate the injury, and increase the risk of undue inflammation. When the displacement is partial, immediate recourse should be had to reductive means, consisting of traction and pressure, aided, if the case prove rebellious, by the subcutaneous section of the tendo Achillis and of any ligaments that may seem to act obstructingly. When replacement is impracticable, the tension of the parts should be relieved by subcutaneous incisions, as this will lessen the risk of sloughing and exposure of the bone; a circumstance inevitably productive of necrosis, and the necessity of partial excision. When such an accident can be prevented, it is consolatory to know that, as in the dislocation backwards, the osseous surfaces become gradually adapted to each other, thereby ultimately permitting a tolerably good use of the limb.

When the bone is entirely displaced, lying immediately beneath the integument and muscles of the instep, the only safe procedure is immediate excision, the ends of the tibia and fibula being placed in the sulcus vacated by the removal of the astragalus, and the edges of the wound being carefully approximated by collodion, so as to insure their prompt reunion without the risk of suppuration. Statistics strongly testify in favor of this plan of treatment. Thus, of fifty-two cases analyzed by Broca, forty-two terminated successfully. The operation, however, is not always free from difficulty, as is exemplified in an instance recorded by Dupuytren, in which the bone was extirpated only after a long and tedious dissection, owing to the pulley-like surface of the astragalus being turned downwards, while its posterior projecting part was hooked in under the tibia. Only about one person in four recovers with ability to move the ankle after such an accident.

A very curious luxation of the astragalus is occasionally seen, originally described by Malgaigne under the name of *substragaloid*, in which this bone is forcibly wrenched from the calcaneum and scaphoid but retains its normal relations with the tibia and fibula. The lesion, which is fortunately of rare occurrence, is also known as the astragalo-calcaneo-cuboid dislocation. Falls from some height in which the part as it strikes the surface is twisted more or less on its axis, are the most common causes of the accident. In a case under my observation in 1880, the patient, a young man, fell off a ladder a distance of about eight feet, upon the floor. When seen an hour after the accident the foot presented very much the appearance which it has in valgus, that is, it was twisted or rotated on its axis and considerably shortened; the outer border was turned upwards, while the inner was greatly depressed, and scooped out as it were. The heel and the toes retained their normal appearance. There was some pain but no swelling of any account, and the bones were immovably interlocked with each other. Various attempts were made at reduction, but the bones yielded only in a very slight degree, and the case was finally abandoned as hopeless. No grave symptoms ensued; and when the patient was last seen, nearly one year after his mishap, he walked with the aid of a properly constructed shoe so well that the slight halt in his gait was hardly noticeable. The difficulty which attends the reduction of this luxation is due, in great degree, if not entirely, to the manner in which the sharp facets of the astragalus are wedged into the cavities of the calcaneum and scaphoid bone. Some impediment may possibly also be caused by the unnatural position into which the tendons of the posterior tibial and plantar muscles are thrown. The division of the tendo Achillis does not seem to help the matter any, and cannot, therefore, be regarded as a factor in the difficulty of effecting reposition. The pulleys might be employed in such a dislocation, but if another case of the kind should come under my observation, I should certainly be inclined to give a fair trial to Mr. Henry Lee's plan, which consists in making extension by means of a fillet fastened in the form of a clove-hitch knot around the anterior portion of the metatarsus, and throwing the noose over the shoulder of the surgeon, while counterextension is made with the knee in the concavity in front of the ankle by pressing against the lower extremity of the leg. The reduction will be materially facilitated if, while these forces are in operation, the astragalus be pushed alternately forwards and more or less laterally by an assistant,

Fig. 679.

Compound Dislocation of the Astragalus Inwards

as in the interesting case of subastragaloid luxation reported by Mr. Pick in the thirteenth volume of the Transactions of the Clinical Society of London.

In *complicated* dislocations of the astragalus, fig. 679, a similar procedure is proper; but here, if the injury be at all grave, the question of amputation will necessarily arise, and much judgment will generally be required to make a just decision. In all severe cases, involving extensive lesion both of the soft structures and of the bones, especially when occurring in weakly or sickly subjects, no experienced surgeon would for a moment hesitate as to the propriety of removing the limb; the only doubt that could possibly arise would be, whether the operation should be done through the leg or through the foot, according to Pirogoff's method.

The after-treatment of these cases requires no special mention. The great points are to give due support to the limb, and to moderate the resulting inflammation by the bandage, leeches, and medicated lotions; and, eventually, by the institution of passive motion to prevent union between the calcaneum and the bones of the leg. If erysipelas should appear, as in severe cases it is very prone to do, early and free incisions will be necessary.

DISLOCATIONS OF THE ANKLE.

Owing to its peculiar mechanism, dislocations of this joint are exceedingly uncommon. The length and width of the malleoli render lateral displacement of the astragalus almost impossible without concomitant fracture of one or both of these projections, while luxation in the antero-posterior direction is nearly as impracticable in consequence of the extraordinary strength and firmness of the ligaments connecting that bone to the tibia and fibula. The effect is that these injuries are almost always of a complicated character, their chief interest depending upon the violence done to the neighboring structures. Most of them, in fact, should be viewed rather as fractures of the tibia and fibula, with displacement of the astragalus, than as dislocations, properly so called, of the ankle-joint.

Luxation may occur in four different directions, forwards, backwards, inwards, and outwards. A few cases have been recorded in which the astragalus was forced upwards between the ends of the tibia and fibula; and Huguier has published the particulars of one in which the foot was turned completely outwards, the toes forming a right angle with the leg, the heel being represented by the external malleolus.

The nomenclature of these luxations has been the subject of a singular caprice, with the result of no little confusion. Instead of considering the astragalus as the dislocated bone, so as to place this joint in the same category, in this respect, as the other articulations, Sir Astley Cooper and others, adopting his example, have made it the fixed point, and the tibia and fibula the movable. This manner of viewing these lesions has occasioned a corresponding change of nomenclature, and as both are radically defective, serving only to cause embarrassment, they should be discarded.

1. Luxation *forwards*, the most infrequent of all, arises from falls on the heel, while the foot is forcibly bent upon the leg, the body being at the same time inclined forwards, so as to throw the strain upon the forepart of the joint. Under these circumstances the ligaments are extensively ruptured, and the astragalus, escaping from the mortise-like cavity of the tibia and fibula, rests immediately in front of the former bone, where it forms a large projection beneath the integument. The diagnostic signs are, the elongated state of the foot, the distance between the leg and toes being materially augmented, the remarkable shortening of the heel, and the effacement of the depressions behind the ankle from the close approximation of the tendo Achillis to the posterior surface of the limb.

The reduction is effected mainly by manipulation. As a preliminary step, the leg is flexed at a right angle with the thigh, to relax the gastrocnemial muscles, when an assistant, seizing the lower part of the leg, gradually pushes it forwards, while the surgeon, grasping the foot, and bending it considerably, forces it backwards, in the opposite direction. In rebellious cases the subcutaneous division of the tendo Achillis greatly facilitates restoration.

2. Dislocation of the ankle-joint *backwards* is caused by violence applied to the anterior extremity of the foot while it is immoderately extended, the knee being at the same time strongly flexed and projected forwards; or, the foot and leg being in this position, the accident may arise from a severe blow upon the lower and back part of the limb, the two forces driving the articulating surfaces in opposite directions. The displacement is ordinarily accompanied by fracture of the inferior extremity of the fibula.

The signs are the reverse of those in the dislocation forwards. The dorsal surface of the foot is shortened, the toes pointing downwards; the heel is elongated and firmly fixed; the tendo Achillis, pushed far back beyond its natural position, stands out in bold relief;

the pulley-like surface of the astragalus is readily perceptible at the back part of the inner ankle ; and the extremity of the tibia forms a hard prominence upon the instep, immediately beneath the integument.

The dislocation backwards is sometimes incomplete, one-half of the articular surface of the tibia resting upon the scaphoid bone and the other half upon the astragalus. The foot, pointed downwards, cannot be put flat upon the ground, and the heel is raised and abnormally prominent, but less so than in complete luxation. A careful examination of the joint will at once reveal the true nature of the case.

The restoration is accomplished in the same manner as in the luxation forwards, the gastrocnemial muscles being thoroughly relaxed, and the bones pulled and pushed in opposite directions. Any tendency that may exist to recurrence of the dislocation, must be counteracted by the division of the tendo Achillis.

Fig. 680.

Dislocation of the Tarsus Inwards.

3. Luxation *inwards* is generally occasioned by falls or blows upon the foot, in which the astragalus is violently rotated upon its axis, and thrust against the inner malleolus, which is usually broken in consequence, being separated obliquely from the extremity of the tibia, as exhibited in fig. 680. It is also liable to be produced by direct injury, as that caused by the passage of the wheel of a carriage. Sometimes the luxation is associated with fracture of the astragalus, or of this bone and the fibula, thus greatly aggravating the case. The articular surface of the astragalus, pointing immediately below the internal malleolus, can easily be perceived in its new position ; the foot is turned inwards, its outer border resting on the floor, while the inner is proportionately raised ; and there is a remarkable prominence at the outer part of the joint, formed by the extremity of the fibula. To reduce this dislocation, the leg is bent at a right angle with the thigh, and steadied by an assistant, while traction is made upon the foot, and the astragalus pushed back into its natural position.

Fig. 681.

Dislocation of the Tarsus Outwards.

4. Dislocation *outwards*, fig. 681, is the most frequent of all the displacements to which this articulation is exposed, a sudden twist of the leg, while the foot is firmly fixed, being the most common exciting cause, although it is often produce by direct violence. The articular, pulley-like surface of the astragalus is forced below the outer malleolus, and there is always fracture of the inferior portion of the fibula ; without this, indeed, the occurrence would seem to be impracticable. This form of luxation was described by most authors, until recently, as displacement inwards.

In this variety of the accident, both malleoli are sometimes broken off, the superior surface of the astragalus slipping away from the articulating surface of the tibia, and lodging in the gutter between this bone and the fibula. The foot in this case is nearly flat, as the patient stands up, with a slight upward inclination of its inner margin, and the lower extremity of the tibia forms a remarkable prominence, rendered the more conspicuous on account of the displacement of the internal malleolus, which, when broken, is always drawn over towards the fibula. Great deformity also exists at the outer border of the ankle, caused by the projection of the inferior fragment of the fibula.

The signs of this accident are unequivocal. The inner malleolus forms a remarkable projection under the skin ; the foot is twisted and easily rotated upon its axis, its inner border resting on the ground ; a depression exists on the outer surface of the leg, above the joint, corresponding with the line of fracture of the fibula, and the astragalus can be

distinctly perceived below the outer malleolus. The reduction is effected by flexing the leg strongly, so as to relax the gastrocnemial muscles, and then drawing the articulating surfaces towards each other in a direction contrary to that of their displacement. The whole procedure is one of great simplicity.

5. In the dislocation *upwards*, of which only a few cases have been recorded, the astragalus is forced upwards between the two bones of the leg, the fibula being fractured some distance above the joint, and widely separated from the tibia. The astragalus preserves its natural direction, but is so firmly impacted as to render its restoration difficult. The two malleolar projections are extremely prominent, and descend nearly as low down as the sole of the foot, which is usually inclined a little to one side. Occasionally, as in a case referred to by Mr. Druitt, fig. 682, the astragalus is thrown up between the tibia and fibula without any fracture of these bones.

In all these dislocations special attention must be bestowed upon the *after-treatment*, as they are all very liable to be followed by severe inflammation, requiring the use of leeches,

Fig. 682.

Dislocation of the Astragalus Upwards between the Tibia and Fibula.

Fig. 683.

Compound Dislocation of the Ankle-joint.

saturnine lotions, and other antiphlogistic remedies. Maintenance of the articular surfaces is effected with the aid of a fracture-box or wire case, well padded, and provided with a foot-piece, to afford complete rest to the injured structures. Passive motion must be instituted at an early period, and persisted in for a long time, otherwise ankylosis will be inevitable. Despite, however, every precaution the ankle-joint will long remain weak, if not permanently crippled.

The ankle is not unfrequently the subject of *compound dislocations*, the wound penetrating the cavity of the joint, and affecting, perhaps, the principal vessels and nerves of the limb, at the same time that there may be violent contusion of the integument, and extensive comminution of the bones of the leg. In such a case, of which a good illustration is seen in fig. 683, from a preparation in my collection, the surgeon could not hesitate as to the course to be pursued. Amputation alone can save life, and should be postponed no longer than is absolutely necessary for the occurrence of the requisite reaction. The lesion is profound, and any attempt to preserve the parts would be worse than foolish. When the injury is less violent, and the constitution sound, conservative surgery will often effect wonders, and is always worthy of a fair trial. When the ends of the bones protrude, excision will generally be the only safe course. Whatever conservative measure be adopted, more or less ankylosis will always be inevitable, although the patient may ultimately regain a tolerably good use of the limb.

The statistics of compound dislocations of the ankle-joint, attended with extensive laceration of the soft parts, clearly show that, as a rule, immediate amputation is the only safe practice. If the operation be postponed until the joint and the surrounding parts are invaded by violent inflammation, death will almost be inevitable, the patient, if he survive the dangers of erysipelas, pyemia, and tetanus, being gradually worn out by profuse suppuration, hectic fever, and constitutional irritation. Secondary amputation is seldom of any avail in saving life. Of fifty-seven cases of this kind, collected in 1877 by Dr. Frank O'Farrall, of Indiana, nearly every one perished. In ten other cases, eight of which came under his personal knowledge, in which amputation was performed at periods ranging from ten days to six weeks, only two recovered.

DISLOCATIONS OF THE TIBIO-FIBULAR JOINTS.

Dislocation of the tibio-fibular joints is an extremely uncommon occurrence; for, independently of their peculiar mode of articulation, and the great firmness and strength of

the connecting media, the resistance offered by the interosseous ligament, and the protection which the fibula receives from its relations with the tibia, are so many causes which interfere with the disruption of their surfaces. It is only, indeed, the most violent injury that can give rise to the accident. There is a form of dislocation of the upper joint which occasionally occurs as a result of excessive relaxation of the fibulo-tibial ligaments, chiefly in weakly, delicate females, allowing the head of the fibula too much latitude of motion ; but this is an occurrence very different from a genuine luxation, which is always occasioned by external force acting directly upon the component elements of the joint. Of the traumatic variety of the lesion only a few examples are on record. In a case observed by Boyer both joints were displaced simultaneously, the foot being at the same time dislocated outwards. Such an accident necessarily implies extensive laceration of the interosseous ligament, and can only happen through a fall upon the foot, or a blow upon the inferior extremity of the fibula, driving the bone upwards and outwards with the whole force of its leverage. Whatever may be the nature of the displacement, reduction is always easily accomplished by flexing the leg at a right angle with the thigh, and pushing the bone back in a direction contrary to that of its luxation. Maintenance, which is usually very difficult, must be effected by long-continued rest of the limb, and the use of a broad, elastic strap with a closely-fitting pad, acting directly upon the head of the bone.

In the *subluxation*, as it may be termed, of the upper tibio-fibular joint, the most suitable remedies are chalybeate tonics, with gentle exercise in the open air, the cold douche, electricity, tincture of iodine, a series of little blisters, and the use of a proper supporter. If the case be rebellious, a delicate tenotomy knife may be introduced subcutaneously, and carried about the joint in different directions, in order to scratch the articular surfaces, so as to provoke an effusion of plastic matter with a view of exciting obliterative inflammation.
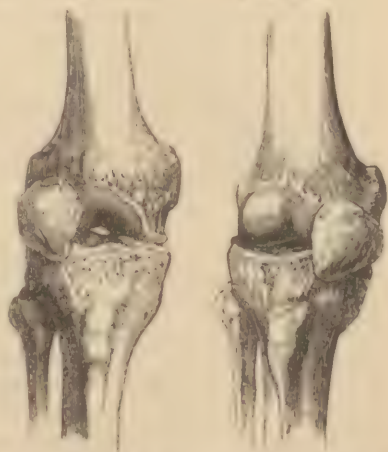
DISLOCATIONS OF THE PATELLA.

It is obvious, from the situation of the patella and the manner in which this bone is imbedded in the tendon of the extensor muscles of the thigh, that it is susceptible of being dislocated only laterally, or outwards and inwards. Displacement downwards is impracticable, while displacement upwards cannot occur without rupture of the ligament by which this bone is connected to the tibia. Each luxation may be complete or incomplete. A remarkable form of the accident, in which the patella is dislocated edgewise, vertically, or upon its long axis, is occasionally met with. Whatever the character of the displacement may be, the occurrence is extremely uncommon. It is most frequent in thin, feeble persons, in whom it is usually produced by very trivial causes, as a sudden twist of the limb in dancing, walking, leaping, or stepping into bed. When there is a faulty conformation of the knee-joint, attended with a relaxed state of the ligaments, it may take place spontaneously, from the action of the extensor muscles conjoined with slight rotation of the leg, the thigh being fixed in the straight position. Sometimes the displacement is occasioned by direct violence, forcing the bone towards the opposite side of the articulation, or twisting it upon its long axis. The accident is most common in young and middle-aged persons. Bryant records a case in a child ten months old.

The amount of injury sustained in these luxations by the ligaments of the knee is variable. When the displacement is partial, as it is in most cases, the probability is that the laceration is very slight, whereas in the more complete forms it must necessarily be proportionately extensive. In some instances the ligament of the patella is nearly torn across, and the lateral ligament is either very much stretched or ruptured.

Of the two lateral dislocations that *outwards*, fig. 684, is the more common, the patella lying at the external part of the joint, its outer edge being directed backwards, and the inner forwards. The signs are characteristic. There is a remarkable depression in front of the knee, with a corresponding prominence on the outside ; the inner condyle can be distinctly felt under

Fig. 684.   Fig. 685.

Dislocation of the Patella Outwards.   Dislocation of the Patella Inwards.

the skin, and the leg is in a painfully extended position, without the possibility of being flexed.

In the dislocation *inwards*, fig. 685, the situation of the patella is reversed, its inner border being turned backwards and the outer forwards. The leg is extended and cannot be bent, the outer condyle looks as if it were depressed, and a characteristic prominence exists at the internal aspect of the knee.

Restoration is effected by placing the patient upon his back, and flexing the thigh upon the pelvis, the lower part of the leg resting upon the surgeon's shoulder, as he sits upon the edge of the bed. The object of this procedure is to relax the knee as completely as possible, when, pressure being applied to the bone with the thumb and fingers, the patella will be drawn into its natural position by the action of the extensor muscles.

Although these dislocations are generally reduced with great facility by the method here advised, and very frequently even by the patient himself, cases occur in which the operation is extremely difficult, the most skilful surgeon being foiled for a long time, notwithstanding the best directed efforts. It is said that Sabatier was completely foiled in an instance of this kind; and Dorsey, on one occasion, nearly experienced a similar fate. Being called to a young lady who had luxated her patella in stepping into bed, he did not succeed in accomplishing his object until after many fruitless attempts, although he saw the patient within five minutes after the accident. When the obstacle is unusually great, it may generally be surmounted by forcibly flexing the leg, and then rapidly extending it; a procedure which has the effect of disengaging the bone from its impacted position. In the case of a boy, aged nine years, mentioned to me by Dr. John H. Packard, of this city, the dislocated bone slipped back into its natural position during the struggles consequent upon the administration of ether.

The dislocation in which the patella is displaced edgewise, *vertically*, or upon its long axis, is a very singular accident, the possibility of which was long denied by nearly all surgeons. It is, indeed, difficult to conceive how a bone, which is so firmly imbedded as this is in tendinous matter, can lend itself to such a freak, which has the effect of turning it completely on its side, so that its outer edge lies immediately under the integument in front of the knee, while the inner rests in the subcondyloid fossa of the femur, being firmly and almost immovably wedged in its new position, the anterior face looking inwards, and the posterior outwards. Sometimes the position of the patella is almost completely reversed, the surfaces changing situations, the anterior looking backwards, and the posterior in the opposite direction.

The accident is generally produced by violent muscular action conjoined with a sudden and forcible twist of the knee; or by a fall or blow upon the bone, at a moment when the leg is semiflexed and strongly rotated upon its axis. A case has been related in which it occurred in wrestling; and at least two instances are known where it resulted from the forcible collision of the knees in a sham fight on horseback. In a case reported by Professor Rochester, of Buffalo, the dislocation was caused by a fall, in which the patient, a youth of sixteen, struck the joint against a curbstone.

The signs are characteristic. The leg is perfectly straight, but may occasionally be slightly flexed, although not without excessive pain; the patella forms, by its outer edge, a hard, prominent ridge in front of the knee; a deep depression exists upon each condyle; and the extensor muscles are in a state of extreme tension.

The reduction is generally extremely difficult, owing to the trouble which is experienced in disengaging the bone from the subcondyloid fossa, where it is almost as firmly impacted as if it were screwed fast. On several occasions, indeed, the most violent efforts, conjoined with the division of the ligament of the patella, were insufficient to accomplish the object. In a case reported by Dr. Gazzam, of Pittsburgh, the only effect of the operation was to render the bone a little more movable, but the attempts to reduce it were as unavailing as before. In another instance, the surgeon, Dr. Wolff, divided the ligament below, and the extensor tendon above, the bone, and yet he found it impossible to effect restoration. Violent disease of the joint ensued, and the patient ultimately perished from profuse discharge and hectic irritation. Fortunately, such measures are not likely to be repeated, since experience has fully shown not only their utter inefficacy, but great danger. In these very rebellious cases, it is not impossible, as suggested by Professor Agnew, that the displaced bone, in addition to its strong impaction in the subcondyloid fossa, becomes engaged in a slit in the fibrous structures in which the patella is naturally imbedded, thus greatly augmenting the difficulty of the reposition.

The proper method of reduction consists in flexing the thigh strongly upon the pelvis, and in bending the leg forcibly, to the fullest extent, upon the thigh, the limb being again

immediately brought into a straight line, at the same time that an effort is made to push the bone strongly over towards the inner part of the joint. By repeating this manœuvre several times in rapid succession, the patella suddenly leaves the subcondyloid notch, and jumps back, with a distinct snap, into its natural situation. Extension, even when carried to excess, is of no avail in effecting reduction; on the contrary, in every case, except one, recently under the care of Dr. Coombs, in which it has been tried, it has signally failed, by causing, apparently, still further impaction of the bone.

After the reduction of these different dislocations, the patient must be subjected for some time to rest and the usual antiphlogistic measures; and when he is able to move about, the joint must be supported for many months with a gum-elastic cap.

Displacement of the patella *upwards* can only occur in connection with a rupture of the ligament of that bone, in consequence of the inordinate action of the extensor muscles, or violence applied to the anterior surface of the knee. The injury is easily recognized by the flattening of the joint, by the projection upon the inferior part of the thigh, and by the inability of the patient to extend the limb. The treatment is the same as in fracture of the patella.

A few instances of *congenital* luxation of the patella are upon record; some of them of an equivocal character, others well authenticated. The occurrence is very uncommon. Perhaps the most remarkable example of double congenital luxation of the patella is one related by Dr. Caswell, of Providence, in which this anomaly occurred in five members of one family, extending over three generations.

DISLOCATIONS OF THE KNEE.

Dislocation of the knee is of very infrequent occurrence, owing, mainly, to the numerous and powerful ligaments by which the articulating surfaces are united together. In this respect, there is no other joint in the whole body so well provided. If it were not for this arrangement, luxation could hardly fail to be very common, as the knee not only admits of extensive motion, but has unusually shallow surfaces, with no very strong support from the neighboring muscles, such, for instance, as exists in the hip, shoulder, and elbow.

The tibia may be thrown from the condyles of the femur in four different directions, forwards, backwards, inwards, and outwards, or to either side. The latter two are the most common, and are always incomplete, owing to the great extent of the articular surfaces, and the difficulty of rupturing all the ligaments in the lateral direction of the joint. The anterior and posterior dislocations are also for the most part partial. Besides these displacements, the knee is subject to a species of subluxation, dependent upon a change of location of the semilunar cartilages. This, indeed, is more common than all the other forms of the lesion together, and is, therefore, of sufficient importance to demand separate notice.

Fig. 686.

Dislocation of the Tibia Forwards.

1. Dislocation *forwards*, fig. 686, is occasioned by falls upon the foot while the knee is in a bent position, or by force acting upon the anterior and inferior part of the thigh, driving the femur backwards behind the head of the tibia; in either case, the occurrence will be promoted if, at the moment of the injury, the leg is slightly rotated upon its axis, so as to increase the strain upon the joint.

The head of the tibia is pushed upwards and forwards, lying in front of the condyles, and generally presenting a somewhat twisted arrangement; the patella is drawn up beyond its natural level, into a sort of hollow, just above the tibia, and may easily be lifted up with the thumb and fingers; the tendon of the extensor muscles is much relaxed; and there is shortening of the leg from an inch and a half to two inches. The condyles of the femur are situated in the ham, where they form a large tumor, which gives the part an unusually prominent appearance, and which occasionally exerts such a degree of compression upon the vessels as to interrupt the circulation in the dorsal artery of the foot.

The complete form of dislocation of the tibia, whether forwards or backwards, must necessarily be attended with most extensive rupture of the ligaments of the joint, and is,

therefore, always to be regarded as a very serious accident. When the condyles are impelled backwards with unusual violence, there will be great danger of laceration of the popliteal vessels, especially of the artery, either in the form of direct rupture, or of a partial destruction of its inner and middle tunics; occasioning, in the one case, copious subcutaneous hemorrhage, the pressure of which may finally cause gangrene of the limb; and, in the other, the gradual dilatation of the artery into an aneurismal tumor, the ultimate effects of which may not be less disastrous. In every instance there is rupture of the popliteal muscle. When the injury to the joint and the parts around is very grave, the danger to limb and life may be such as to require amputation; but, ordinarily, the patient rapidly recovers from the immediate effects of the lesion, and eventually obtains a useful limb, although it may remain weak for a long time.

The reduction is readily effected by counterextending the thigh and pulling the leg somewhat backwards, the surgeon's arm resting in the ham, and pressure being made upon the head of the tibia.

The following case, the only one that I have ever seen of dislocation of the head of the tibia forwards, affords a good illustration at once of the symptoms of the accident, and of the proper method of reduction.

A very large, stout, heavy woman, forty-eight years of age, received a severe fall from the sudden slip of the right foot, which, bending outwards, caused the whole weight of the body to be thrown upon the corresponding knee. I saw her four hours after the occurrence of the accident, when several fruitless attempts had already been made at reduction. The knee, which was very painful and a good deal swollen, appeared to be unusually wide from side to side; a circumstance partly due to the tumefaction of the soft parts. The leg was one inch and a half shorter than the opposite one, and in a straight line with the thigh. The patella had sunk behind the head of the tibia, into a kind of hollow, which imparted to the front of the joint a flattened aspect. Upon grasping the bone, however, with the thumb and fingers, it was easily drawn forwards, leaving a remarkable vacuity behind, in consequence of its distance from the inferior extremity of the femur. The condyles of the thigh-bone lay in the popliteal space, posterior to the head of the tibia, where they formed a large prominence, more distinct on the inside than on the outside, and situated, as it were, in the upper and back part of the leg, the muscles of which were unusually tense. The head of the tibia lay in front of the condyles, where its outline could easily be traced with the eye and finger. Above this bone, as already stated, was the patella with its ligament and the tendon of the extensor muscles, forming a broad, thick cord in front of the thigh-bone, from which it was removed more than two inches. The leg was easily drawn away from its fellow, but could not be carried inwards, showing that there was extensive rupture of the internal lateral ligament. There was no contusion of the soft parts, nor any discoloration of the integument.

Chloroform having been administered, a stout lac was applied to the upper part of the thigh, and confided to an assistant, to make the requisite counterextension, while extension was made by another assistant grasping the foot, the limb being in the extended position. Placing now my left forearm behind the knee, and requesting the aids to pull gently and steadily, I suddenly, with my right hand, bent the leg backwards, and thus in a few seconds effected the reduction, the bone returning with a distinct snap. The limb being laid in an easy position, cold cloths were applied to the knee, and half a grain of morphia administered to allay pain and prevent spasm.

No untoward symptoms appeared after the reduction. The patient kept her bed for nearly a fortnight, and made free use, after the first twenty-four hours, of medicated lotions, to moderate and subdue inflammation. Purgatives and light diet were also enjoined. In due time passive motion was instituted; the limb was frequently bandaged; and in less than a month from the time of the accident, the woman was able to walk about the house with the aid of crutches. The joint, however, remained weak for a long while, and even now, several years after the occurrence of the injury, the slightest fatigue is attended with temporary lameness.

2. Luxation of the tibia *backwards*, fig. 687, is so rare an accident that the possibility of its occurrence was called in question by many of the older surgeons. Modern experience, however, has not only shown the error of this opinion, but has pointed out with great accuracy the mechanism, signs, and method of reduction of the displacement. The causes are similar to those of luxation forwards.

The head of the tibia lies in the ham, where it compresses the popliteal vessels and nerves, pushes back the popliteal and other muscles, and forms a distinct prominence, easily perceptible by sight and touch. In front of the joint is the large projection repre-

senting the condyles of the femur, and immediately below it the patella, with a strongly marked depression on each side, its ligament being drawn tightly under the articular surface of the thigh-bone, and the tendon of the extensor muscles firmly stretched. The leg, which has the appearance of being slightly rotated, is always considerably shortened, although less than in the luxation forwards. In regard to its position no definite rule can be laid down, as it varies much in different cases, being at one time flexed, at another extended.

The reduction is effected upon the same principles as in the dislocation forwards, the thigh and leg being pulled in opposite directions, and pressure made upon the head of the tibia, while the patella is fixed by the hand in front.

3. The *lateral* dislocations of the tibia are always incomplete. They occur with nearly equal frequency, generally from falls, or from the passage of the wheel of a carriage, in which the femur is violently twisted while the leg itself is firmly fixed. Another cause is force applied to the lower and lateral part of the leg at a moment when the knee rests upon a hard, resisting object, and the trunk is inclined sideways, thus throwing the whole strain upon the edge of the joint. Much injury of the soft parts almost always attends these displacements, and the leg generally presents a remarkably twisted appearance.

Fig. 687.

Dislocation of the Tibia
Backwards.

In the luxation *inwards*, fig. 688, the head of the tibia is thrown off the corresponding condyle of the femur, and forms a large tumor at the inner side of the knee. In the displacement *outwards*, fig. 689, the signs are reversed, the tibia projecting at the external aspect of the joint, and the condyle at the inner. The leg, in both cases, is slightly flexed and rotated on its axis, the extensor muscles are relaxed, and a marked depression exists in the natural situation of the patella, which is pushed to one side or the other, according to the character of the displacement. The diagnostic signs are the twisted state of the limb, and the great increase of the width of the joint.

Owing to the extensive laceration of the ligaments of the joint, the lateral dislocations are reduced with great facility. All, in fact, that is necessary, is, while the thigh is fixed by an assistant, to pull the leg by grasping it just above the ankle, and to push the head of the tibia in a direction contrary to that of its displacement.

Fig. 688.   Fig. 689.

Dislocation of the Tibia   Dislocation of the Tibia
Inwards.   Outwards.

The after-treatment of all these luxations must be conducted upon strictly antiphlogistic principles. The patient should be confined to his bed for at least a month, and blood should be freely taken by leeches, and even by the lancet, if he is robust, or if the inflammation runs at all high. The great danger is ankylosis, which it will require the utmost care and diligence to prevent. The joint must be supported in an easy position, and passive motion must not be instituted too soon, lest it interfere with the reunion of the ruptured ligaments. When the patient is able to walk, the knee must be protected with a laced cap, and its tone improved by the cold douche, stimulating embrocations, and dry frictions.

Complicated dislocations of the knee are not of infrequent occurrence, and are always to be dreaded on account of the constitutional sympathies which they are sure to awake. When the joint is laid freely open, and the soft parts are otherwise seriously injured, there can hardly be any doubt as to the propriety of immediate amputation, for such cases nearly always terminate unfavorably, the patient dying either of tetanus, erysipelas, pyemia, traumatic fever, or excessive suppuration; or, if he chance to recover, he will owe his life to good luck rather than to the skilful management of his attendant. It is generally difficult to make the patient comprehend the importance of what will always appear to him so harsh

a measure, especially if he is a young man of temperate habits, and in excellent health at the time of the injury ; he will resist the operation in spite of the arguments and entreaties of his surgeon, and will only consent when it is too late to be of any benefit. I am satisfied that there is no class of lesions more dangerous to both limb and life than compound dislocations of the knee, especially when at all severe ; and I, therefore, do not hesitate to recommend the prompt adoption of decisive measures. When the soft parts are not too much affected, excision may occasionally be substituted for amputation, as in the cases reported by White and other surgeons, although, in general, the latter is unquestionably by far the safer procedure.

Dislocations of the knee are sometimes complicated with laceration of the popliteal vessels ; an occurrence in which the only resource is amputation of the thigh, performed without delay, immediately above the seat of the injury. Mr. George Lowe recently reported two cases in which this expedient was necessary.

Examples of *congenital* luxation of this joint have been reported by different authors, as Cruveilhier, Robert, Guérin, Kleeberg, and Bard. The displacement, which is generally incomplete, and associated with other malformations, may occur in any direction, but that forwards is by far the most common.

In 1863, Dr. Karsner sent to me at the College Clinic a female child, two years of age, on account of a congenital dislocation of each knee, accompanied by absence of the patella. The tibia lay in front of the femur, the situation of its head being indicated by a distinct prominence, and by a peculiar crescentic fold in the skin. The condyles of the thigh-bone, on the contrary, formed a very large tumor on the back part of the leg, and seemed to have been considerably rounded off. The leg was shortened about two inches and a half. The child, which was puny and unhealthy, could readily extend the limb, as well as move it laterally, but was unable to flex it at the joint, nor could this be done beyond a few inches by my own efforts. The dislocation was reduced by extension and counter-extension, but immediately recurred upon their cessation. In another case, in an infant four weeks of age, the articular extremities were in a direction precisely the reverse of the preceding, the head of the tibia being behind, and the condyles of the femur in front and internally. There was no patella on either side.

DISLOCATIONS OF THE SEMILUNAR CARTILAGES.

The semilunar cartilages are subject to a species of displacement known under the name of subluxation, an affection which was first described by Mr. Hey, of Leeds, and which is most commonly met with in feeble, delicate persons, the subjects of chronic disease of the knee. A sudden and forcible twist of the joint occasioned by striking the toes against a stone, or an accidental slip in walking while the foot is turned inwards and the thigh outwards, is the usual cause of the mishap. The lesion essentially consists in the partial removal of the semilunar cartilages from their natural position, thus allowing them to become wedged in between the tibia and femur, simply as an effect of the relaxed condition of their ligamentous connections. Occasionally, however, the wrench is so violent as to detach some of these connections from the bone.

Well-marked *symptoms* always attend this form of luxation. The patient is suddenly rendered conscious of some accident, which causes him to feel faint and sick, and immediately compels him to sit down. The pain is very excruciating, and he is unable to stand, or to extend the limb, which is generally semiflexed. If the joint be examined within a few minutes after the occurrence of the injury, its size and shape will be found to be perfectly natural, and an inexperienced surgeon might conclude that the case was merely a slight sprain. In a short time, however, considerable swelling sets in, and the articulation before long imparts a distinct sense of fluctuation from the deposit of synovial fluid, caused by inflammation of its lining membrane. The excessive pain and shock are due to the pressure which the tibia and femur exert upon the displaced cartilages, in consequence of the changes in their mutual relations, and, also, to the forcible distension of some of the ligamentous structures of the joint. The dislocation, having once taken place, is extremely liable to recur from the most trivial causes ; and under such circumstances I have repeatedly noticed that, although the patient was always obliged to keep his leg in a slightly bent position, yet he was able, when he sat on a high seat, to move it nearly as well as the sound one.

The *reduction* must be performed under an anæsthetic during recumbency, with the thigh strongly flexed upon the pelvis. The surgeon, placing his arm in the popliteal hollow, and grasping the limb just above the ankle, bends the knee suddenly and forcibly,

and then rapidly extends it, at the same time imparting a movement of rotation to the leg. By this triple manœuvre the pressure of the condyles is taken off the semilunar cartilages, and the parts are enabled to return to their natural situation. Sometimes the ingenuity of the patient enables him to effect reduction when that of the surgeon fails. Sir Astley Cooper mentions the case of a gentleman who was in the habit of relieving himself by bending the thigh inwards and pulling the foot outwards, as he sat upon the floor. In some instances, again, the parts return of their own accord after a failure of the usual means either during sleep, or while the patient is sitting up.

After such an occurrence the joint must be kept perfectly at rest until it has, in some degree, recovered its original tone, when the patient should wear an elastic knee-cap, and guard against any sudden twist of the limb, to prevent a recurrence of the dislocation. Sorbefacient liniments and the cold douche will be of service in promoting the removal of effused fluids, and imparting vigor to the relaxed structures.

DISLOCATIONS OF THE HIP-JOINT.

Dislocations of the ilio-femoral joint are far less frequent than those of the shoulder, a circumstance which evidently depends more upon the peculiarity of structure of these articulations than upon any difference in their motions, which are sufficiently free and varied in both, although certainly less so in the former than in the latter. The hip-joint affords the best type of the ball and socket joint in the body. The acetabulum is of immense depth, and, therefore, readily accommodates the large, well-formed hemispherical head of the femur. The glenoid cavity of the scapula, on the other hand, is very shallow, and yields very inadequate support to the head of the humerus, in the varied and extensive movements of the shoulder. Besides, there is a great difference in the ligaments which bind the bones to each other in these articulations. The capsular ligament of the shoulder is comparatively weak, while that of the hip is by far the most powerful in the body, at the same time that it is most closely and firmly fitted around the parts which it is designed to retain and to protect. In addition to this, the latter has a ligament peculiar to itself, the interarticular, which serves to connect the head of the bone directly to the margin of the acetabulum, an arrangement which is altogether wanting in the shoulder, the long head of the biceps forming a very imperfect substitute. Finally, the hip-joint is under the cover and protection of large and powerful muscles, which are much more capable of resisting the effects of dislocating agents than those of the shoulder, which, in fact, often rather promote the occurrence of the accident, if they do not actually produce it by their own ill-directed efforts.

Dislocations of the hip-joint are much less frequent in women than in men, simply because of the differences in their occupations. If women were as much exposed to all kinds of external violence, especially to falls and blows, as the other sex, they would, doubtless, suffer quite as often, not only from these accidents, but also from luxations of the other articulations. Displacements of the shoulder occur at least from six to eight times as frequently in the male as in the female, and in the hip-joint the disproportion is still more remarkable.

Displacement of this joint is, next to that of the shoulder, more frequent than in any other joint of the body. Of the cases collected by Malgaigne, 494 in all, 321 occurred in the shoulder and 34 in the hip, the clavicle coming next in order.

Age exerts an extraordinary influence upon the production of these accidents. It is very uncommon to meet with a luxation of the hip-joint in children, because a degree of force capable of inducing it in the adult would be more likely to lead to separation of the epiphyses of the bone, owing to its imperfect development, and consequent inability to resist external injury. In the old the lesion is also unusual, for at that period of life the osseous tissue is so brittle as to be liable to be broken by the slightest causes. Hence, fracture of the neck and upper extremity of the femur is much more frequent in both sexes after the age of fifty-five than displacement of the head of that bone from the acetabulum. Dislocation often occurs from the twentieth to the twenty-fifth year, but is most common from the thirtieth to the forty-fifth. The youngest case of displacement of the hip-joint of which I have any knowledge happened at six months; the oldest at eighty-six years.

The head of the femur is susceptible of being dislocated in four principal directions; upwards, upon the dorsal surface of the ilium; backwards, into the sciatic notch; downwards, into the thyroid foramen; and forwards, upon the pubic bone. Of these displacements, the first is by far the most common; next in order of frequency is that into the sciatic notch, and the rarest of all is the last. Sir Astley Cooper, whose experience in

dislocations of the hip-joint was very great, estimated that out of every twenty cases twelve would be on the dorsal surface of the ilium, five in the sciatic notch, two in the thyroid foramen, and one on the pubic bone. Of 104 cases, collected by Professor Hamilton, 55 were iliac, 28 sciatic, 13 thyroid, and 8 pubic. The observations of surgeons generally accord with the results of these statistics. To the extreme rarity of the last two forms of luxation every practitioner can bear testimony. The reason of the great frequency of iliac dislocations is to be found, I presume, rather in the position in which the thigh is usually placed at the moment of the accident than in any differences in the structures of the hip-joint at particular portions of its extent, certain attitudes of the limb always favoring the occurrence of certain displacements.

A simultaneous dislocation of both hip-joints is occasionally met with, as in an instance recorded by Professor William Gibson; but such an occurrence is exceedingly uncommon. The accident may be symmetrical, or the head of one bone may lie in one situation and that of the other in another. Thus, Cooper has recorded a case in which one displacement was iliac and the other thyroid. A similar example occurred to Dr. Boisnot, of this city, in a man, forty-two years of age, who was crushed by the fall of a heavy sack of wool in which one thigh-bone was luxated upon the iliac and the other upon the pubic bone. In a case of double dislocation witnessed by Dr. Packard, one bone rested on the ilium, and the other in the thyroid foramen. T. C. Barker has reported an instance of double thyroid, and H. L. Pritchard one of double iliac, displacement; Pollard, of iliac and thyroid; Crawford, of iliac and sciatic, and W. O. Roberts of thyroid and iliac. These accidents are generally occasioned by heavy pressure, blows, or falls, inflicted at a moment when the body is "doubled up," or compressed into a narrow space.

Besides these luxations, there are several others, which will be briefly noticed under another head, as rare, unusual, or anomalous dislocations of the hip-joint. It will greatly simplify the study of the four principal forms of this accident if they be described as the iliac, sciatic, thyroid, and pubic, terms which, as they are easily understood, cannot fail to convey a clear general idea of the locality of each displacement to which they refer.

All these luxations are complete, the head of the femur being forced entirely out of its socket. Great violence is necessary for their production, and they always take place so much the more easily in proportion as the force is diffused over a large surface. I am not acquainted with a solitary instance in which they were the direct and immediate result of muscular contraction, as occasionally happens in dislocations of the shoulder-joint. Such an event could only occur when there is previous disease of the articulation, destroying its ligamentous connections. In what is called a spontaneous luxation, of which a number of examples are upon record, the displacement is always partial, the head of the femur never completely forsaking the cotyloid cavity. The violence in these accidents may act either directly upon the hip, or indirectly through the knee or foot, and the nature of the displacement will depend upon the direction in which it is applied. Thus, luxation into the thyroid foramen can only be produced when the limb is powerfully abducted at the moment of the accident, and the occurrence will be promoted if the strain is increased by the person having a heavy weight upon his shoulder.

Abduction of the limb seems to be the position most favorable to the production of dislocations of the hip-joint. Mr. Henry Morris, of London, in 1877, published a highly valuable article on this subject in the Medico-Chirurgical Transactions, in which he has clearly shown that in abduction the head of the femur is more than half out of its socket, and that, while in this condition, all the strong portion of the capsule is relaxed, excepting during complete extension, when the innermost fibres of the ilio-femoral ligament are rendered tense. "In fact," he adds, "it may be said that there is a natural tendency for the head of the femur to be displaced during abduction of the thigh." In corroboration of this view, Mr Morris has adduced the results of fifteen experiments performed, under varying circumstances, upon the dead subject, as well as several clinical observations verified by dissections after death, all tending to confirm his statements. These conclusions are now generally accepted, and they must, it is obvious, exert an important influence upon the reduction of the dislocations of this articulation. It was known, long ago, that at least two dislocations of the hip-joint, namely, the thyroid and the pubic, were, as a rule, caused during the abduction of the thigh bone; but it remained for the London surgeon to point out the fact that the two posterior displacements are generally produced in a similar manner. In none of his experiments did the head of the bone escape through a "button-hole" opening at the lower posterior part of the capsule; instead of this it always tore up a large flap in that situation.

In every dislocation of the hip-joint there must necessarily be more or less extensive

injury of the soft parts. The capsular and interarticular ligaments are torn, and a similar fate is always experienced by the rotator muscles of the femur, as well as by the pectineus and quadratus. The gemellus also generally suffers. The two large gluteal muscles, however, and the psoas and iliac, which are attached to the small trochanter, usually escape, or are, at most, only put upon the stretch. Occasionally a small scale of bone is detached from the head of the femur at the insertion of the round ligament, and a fracture of the rim of the acetabulum is also a possible occurrence. In what are known as the regular, or more common, dislocations, the capsular ligament is always torn at its weaker parts, the stronger, or ileo-femoral portions, generally retaining their integrity. When the violence has been uncommonly severe, a considerable effusion of blood may be expected within and around the joint; and there will then also be likely to be more or less contusion of the integument and muscles, especially if the injury has been direct.

1. In the *iliac dislocation*, the head of the femur is thrown upwards and backwards upon the dorsal surface of the ilium, fig. 690, resting in the fossa of that bone, either under or upon the small gluteal muscle. In some cases, although rarely, it is thrust a good deal forwards instead of backwards.

The accident occasionally occurs very early in life. The youngest case on record is one of eighteen months, treated by Dr. Fanning, of Catskill. Kirby, Yandell, and Buchanan

Fig. 690. Fig. 691.
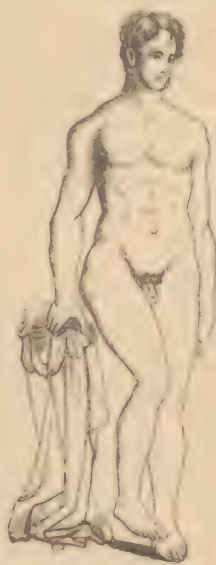
Dislocation on the Back of the Ilium.

met with it at three years; Image at three and a half; Litten at four; Travers at five; J. C. Warren at six; Sir Astley Cooper at seven. I have seen it at six and at fourteen years, in male patients sent to me, respectively, by Dr. Whiteside, of Haddington, and by Dr. Saulsbury, of Delaware. In 1876, a girl, seven years old, was brought to the College Clinic, who at the age of six months had dislocated the left hip-joint. All the symptoms existed in a characteristic degree.

The *symptoms* of the accident, fig. 691, are sufficiently obvious, rarely exhibiting any material variation. The hip is considerably deformed, being more salient than natural, the upper part of the thigh is unusually full, and the gluteo-femoral crease is on a plane higher than common. The great trochanter is carried upwards and inwards, in closer proximity with the anterior superior spinous process of the ilium, and is more conspicuous than in any other accident except coxalgia, in its advanced stages. The head of the bone may readily be felt in its new situation, particularly in thin, lean subjects, and on rotating the thigh it is found to roll about under the finger. The limb is from one and a half to two and a half inches shorter than in the normal state; the foot is strongly inclined inwards, the big toe pointing towards the opposite tarsus; the knee, as the patient stands, is a little above and somewhat in advance of the sound one, any attempt to turn it out proving impracticable, and causing severe pain; the thigh is slightly bent

upon the pelvis, and may with a little effort be carried across the sound one : the leg is flexed upon the thigh ; the heel is raised off the floor ; and the limb, firmly fixed in its constrained position, cannot be restored to its proper length without reducing the dislocation, nor can it be moved except a little inwards. When the patient is recumbent, the foot rests on the bed, but the knee is considerably raised, and all attempts to extend it are unavailing.

A few examples in which the limb in the dorsal luxation was everted and slightly abducted have been reported ; a condition due, as is supposed by Bigelow, to a rupture of the outer fibres of the ileo-femoral ligament. It is a singular fact that, when this lesion in this ligament exists, eversion and inversion may occasionally be produced at pleasure simply by rotating the affected limb.

The luxation is generally occasioned by falls upon the knee or foot while the thigh is strongly abducted and thrown forwards beyond the line of the body. In this way the head of the femur, being powerfully rotated inwards, is thrust forcibly upwards and backwards, tearing the capsular ligament in that direction, escaping from the acetabulum, and lodging in the lower part of the iliac fossa, under or upon the small gluteal muscle. The accident may also be produced by violence applied directly either to the hip or to the upper extremity of the femur, as by the fall of a heavy body, when the limbs are widely separated, and the trunk is inclined strongly forwards. The two obturator, geminal, quadrate, and pyriform muscles are greatly stretched, and sometimes even partially ruptured, while the psoas and iliac are relaxed, as are also the adductor, pectineal, and gluteal. The round ligament is, of course, torn. The powerful tension into which the external obturator muscle, a fleshy mass of large size and great strength, is thrown by the accident, is the immediate cause of the immobility of the limb, of the inversion of the foot and knee, and of the excessive pain which follows any attempt at rotation and abduction.

The *diagnosis* is deduced from the great prominence of the trochanter and its proximity to the anterior superior spinous process of the ilium ; the inverted and shortened state of the limb ; the fixed position of the head of the bone in its new situation ; and the impossibility of abducting and rotating the knee.

Fig. 692.
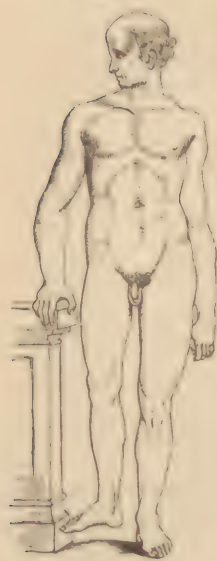
Intracapsular Fracture of the Thigh-bone.

The accident with which this luxation is most likely to be confounded is fracture of the neck of the femur, fig. 692, within the capsular ligament. In general, however, the diagnosis is established with great facility. All, in fact, that is necessary is to remember that, in fracture, the trochanter is drawn backwards and is less salient than usual ; that the foot is everted instead of being inverted, as in luxation ; that the limb may readily be restored to its proper length by extension, but immediately resumes its former position when the extension is discontinued ; and, finally, that, when the ends of the fragments are brought in contact with each other, crepitation may promptly be elicited by rotating the thigh. Moreover, the limb may be moved, although not without great suffering, in every direction, and not merely inwards and slightly upwards, as in dislocation. In impacted fracture, a very rare occurrence, the head of the bone may always be felt in its natural position.

Doubt in regard to the diagnosis occasionally arises from injury of the superior extremity of the femur, attended with fracture of the great trochanter, from the detached fragment being drawn upwards and backwards by the action of the muscles, into the fossa usually occupied by the head of the bone in luxation. The signs of distinction are, the mobility of the broken piece, the absence of inversion of the limb, and our ability to carry the thigh about in different directions, although not without severe pain.

Severe contusion of the great trochanter, unaccompanied by fracture of the bone, may occasion uncertainty in regard to the diagnosis. The accident is liable to be followed by great pain and swelling in the upper part of the thigh and groin, by inability of motion, and by complete eversion of the limb, which, at the same time, feels numb and heavy, and is often swollen throughout its entire length. The absence of shortening of the limb, and the facility with which the head of the bone moves in its socket, are the signs which serve to distinguish the lesion from dislocation.

The symptoms of iliac dislocation are sometimes painfully simulated by fracture of

the acetabulum, allowing the head of the femur to escape into the pelvis. Or, a portion of the margin of this cavity may be broken off, and the bone ascend into the iliac fossa. This distinction is based upon the existence of crepitation and the greater amount of injury sustained by the soft parts. When the cotyloid border is detached, the fact will be denoted by the incessant tendency to recurrence of the dislocation after reduction. If the femur has pierced the pelvis the limb will be materially shortened and in a constrained, almost fixed position.

The degree of shortening attending the iliac variety of displacement is best ascertained by extending a piece of tape, or a graduated measure, from the anterior superior spinous process of the ilium to the centre of the tuberosity of the internal condyle of the femur on each side. Or, instead of this, the tape may be carried along the middle line of the body, from the centre of the fourchette of the sternum to the sole of the foot, placed at a right angle with the leg. The difference in the result will indicate the extent of the defect. There is considerable variation in regard to the amount of shortening in different cases. On an average, it may be stated to range from two inches to two inches and a half; but occasionally it is as much as three inches and a half, and, on the other hand, as little as an inch and a half.

The limb in this variety of luxation, instead of being inverted, is occasionally everted; sometimes in a remarkable degree, and without any ascertainable cause. Dr. E. M. Moore, of Rochester, recently reported an example in which, during an attempt at reduction, the head of the bone was reversed, so that it pointed anteriorly on the dorsal aspect of the ilium, with the toes projecting outwards, the shortening amounting to over two inches. In cases of this kind the diagnosis must hinge mainly upon the absence of crepitation and the great rigidity of the affected limb from the impaction of the head of the thigh-bone. Shortening is usually a prominent symptom.

Writers in describing this form of luxation almost invariably assert that there is less prominence of the great trochanter than in the natural state, whereas a little reflection will serve to show that such an opinion is altogether untenable. To satisfy one's self upon this subject, it is only necessary to examine the position which the femur assumes in consequence of the dislocation. The whole limb being strongly rotated inwards, the trochanter, as it lies in its new situation just above the rim of the acetabulum, or partly above and partly below, is necessarily tilted up and brought forwards, so as to augment, in a very striking degree, its saliency beneath the integument and muscles of the gluteal region. An excellent idea of the changes produced in the projection of the trochanter may be formed by alternately inverting and everting the foot strongly in the ordinary standing attitude, so as to make, on the one hand, the big toe of the rotated limb point against the opposite tarsus, and, on the other, the heel against the hollow between the tendo Achillis and the inner malleolus. In the former position, the bony eminence will be remarkably prominent, jutting out as a rounded mass, whereas, in the latter, it will hardly be perceptible, or, at most, comparatively small. In displacement of the head of the bone upwards and backwards, the projection is abnormally distinct, and is, therefore, a sign of great diagnostic value.

2. The *sciatic dislocation* commonly results from falls or blows applied to the foot or knee while the body is strongly inclined forwards upon the thigh, or the thigh upwards upon the pelvis. In either case the head of the bone, breaking through the posterior and lower part of the capsular ligament, slips backwards from its socket, into the sciatic notch, fig. 693, resting upon the pyriform muscle, between the sciatic ligaments and the convex surface of the iliac bone. The capsular ligament is severed, and the psoas, iliac, and obturator muscles are put upon the stretch, and occasionally otherwise injured. In a case observed by Mr. Syme the head of the bone rested upon and compressed the sciatic nerve.

This dislocation in its *symptoms* bears so close a resemblance to the iliac that some writers are disposed to regard them merely as modifications of the same lesion, the one being an exaggerated form of the other. I have myself, however, always looked upon them as separate and distinct varieties. The adjoining sketch, fig. 694, conveys an excellent idea of the appearances presented by the injured limb, and a comparison between it and the preceding will serve to show that they differ from those of the iliac luxation only in being less marked. The limb is shortened from half an inch to an inch, and so firmly impacted in its new position that it is impossible to bend or rotate it; the great toe rests against the ball of the sound one; the knee is turned in and advanced over its fellow, but not so much as in the dislocation upwards; the trochanter, which is uncommonly prominent, is lower down than natural, and, consequently, farther off from the anterior superior spinous process of the ilium; and the head of the bone is so deeply buried

in the sciatic hollow as to render it very difficult to detect it, except in thin, emaciated persons; not unfrequently, however, if, indeed, not generally, it may be felt by the finger inserted into the rectum or the vagina.   Both the thigh and leg are slightly flexed.

Fig. 693.

Fig. 694.

Dislocation into the Sciatic Notch.

The characteristic signs of the dislocation are, the situation of the head of the bone behind the acetabulum, a short distance above the tuberosity of the ischium; the firm impaction of the thigh in its new locality; the unusual distance between the trochanter and the spine of the ilium; and the fact first pointed out in 1877 by Dr. Oscar H. Allis, of this city, and soon afterward by Professor Dawson, of Cincinnati, that, when the two limbs, fig. 695, are raised to a right angle with the recumbent trunk, the shortening of the affected one will be materially increased, being seldom less than two inches instead of six or eight lines, as when the limbs are extended.   Another mark of distinction is that, if the thigh be extended, the back immediately becomes arched, so as to leave a hollow or space between it and the bed, and conversely.

Fig. 695.

Showing the difference between the two limbs.

In a sciatic dislocation recently under my charge, in a thin man, twenty-eight years of age, the limb was nearly one inch shorter than the sound one, and strongly flexed at the knee.   When an attempt was made to bring the thigh and leg in a straight line, the man complained of severe pain, and immediately raised his loins in such a manner as to admit of the ready passage of the fist and arm underneath.   When the body was extended, the knee became immediately bent, as at the time of the accident.   The limb lay close by the side of its fellow, and could not be carried either backwards or outwards, but was easily flexed on the pelvis.   When the man stood up, he threw his body very much forward, and the limb hung close by the side of the other, the knee being far in advance of the sound one and crossed somewhat over it; the foot was almost parallel with the other, but the heel was raised from the floor nearly two inches.   Both in standing and lying, the trochanter was at least one inch farther off from the anterior superior spinous process of the ilium than the opposite one, besides being unusually prominent; and the head of the femur could be distinctly felt on the dorsal surface of the ilium, at the upper part of the sciatic notch, rolling under the finger when the limb was rotated upon its axis.

In a case of unreduced sciatic dislocation of the left side, of eight years' standing, in a man twenty-five years old, I found, upon dissection, great inversion of the knee and foot, shortening to the extent of nearly one inch and a half, and great wasting of the entire limb.   The external gluteal muscle was nearly normal, but the middle and internal were excessively atrophied, shortened, and fused together, their fibres being very pale, sparse, and partially transformed into fatty and fibrous tissue.   The pyriform, also much reduced in size, was stretched over the head of the femur, and inseparably blended with the inner and middle gluteal.   The geminal muscles and the tendon of the internal obturator were elongated, and twisted around the neck of the bone.   The quadratus was lengthened, but not otherwise perceptibly changed.   The great trochanter was three inches and a half from the anterior superior spinous process of the ilium and four inches and a half from the crest of that bone, its top being on a line perpendicular with it.   The head of the femur lay across the upper part of the sciatic notch, two inches from the tuberosity of the ischium, and a few lines from the posterior inferior spinous process of the ilium, its distance from the crest of that bone being two inches and three-quarters.   It was nearly completely divested of cartilage, very rough, and studded with numerous little bony eminences.   Surrounding it was a false capsule, varying in thickness from the fourth of a line to a line and a half, and composed principally of the remnants of the pyriform and the two small gluteal muscles; it was translucent at several places, rough on its inner surface, with here and there a serous, glistening point, and presented a large quantity of reddish, filamentous tissue, immediately below the head of the bone, to which and to its neck it was firmly adherent.   The ilium and the sciatic ligaments which accommodated the bone were sound, and it was evident, from the manner in which the parts had been impacted, that but little motion existed after the accident.   The acetabulum was nearly filled by a fibro-cartilaginous substance, its edges having been rounded off by absorption.   No trace could be discovered of the capsular and round ligaments.

3. In the *thyroid dislocation*, fig. 696, the head of the femur is thrown downwards and forwards into the thyroid foramen, resting upon the external obturator muscle, by which that opening is covered in, the great trochanter being turned backwards towards the acetabulum.   It is caused by falls upon the foot or knee while the thigh is widely separated

Fig. 696.   Fig. 697.

Dislocation into the Thyroid Foramen.

from its fellow, and inclined sharply backwards.   It may also be occasioned by a heavy body, such, for example, as a sack of corn, striking the hip while the limb is in a state of abduction, and the trunk bent forwards.   The gluteal muscles are drawn downwards, considerably flattened and put upon the stretch; the pyriform is elongated and tense; the

interarticular ligament and the lower portion of the capsular ligament are torn; and the extensor muscles of the thigh form a hard, firm mass, reaching from the pubic bone to within a short distance of the knee.

The thyroid dislocation occasionally occurs at a very early age, as in a case recorded by Powdrell, in a child six months old. Bigelow met with one at the age of two years, and several other examples of a similar kind are to be found in the annals of surgery.

The *symptoms*, as seen in fig. 697, are remarkably prominent and distinctive. The hip is deprived of its convexity, and in place of the projection formed by the trochanter there is a decided flattening, and sometimes even a positive depression; the trochanter, moreover, is removed considerably farther from the anterior superior spinous process than in the natural state. The limb is increased in length from an inch and a half to two inches, and, owing to the tension of the gluteal muscles, stands off in an awkward and constrained manner from the sound one, the knees being in consequence widely apart from each other. The trunk is bent forwards by the action of the psoas and iliac muscles, which are greatly stretched; and a large tumor is perceptible in the region of the thyroid notch, caused by the presence of the head of the femur, which, however, can only be felt distinctly in thin subjects, and in the absence of swelling. The knee is extended and lower than the sound one, and the foot, usually a little everted, is widely separated from its fellow. The movements of adduction, extension, and rotation are impracticable, but those of abduction and flexion may be executed by the surgeon, although not without excessive suffering. In many cases the head of the displaced bone may be distinctly perceived by the finger introduced into the rectum or the vagina.

When the patient stands erect and is viewed in profile, the body and limbs are found to form an obtuse angle with each other, owing to the contraction of the gluteal muscles, on the one hand, and to that of the iliac and psoas, on the other, the latter presenting at the same time a tense ridge at the side of the thigh, perceptible both by sight and touch; the toes rest on the floor while the heel is usually somewhat elevated; the hip, by its flattened condition, contrasts strikingly with its fellow; the femoro-gluteal crease is lower than natural; and the knee is greatly in advance of the opposite one. If the body be extended so as to bring it on a line with the thighs, the effort will not only fail, but cause severe pain.

The diagnosis is based upon the widely separated state of the knees, the elongation of the limb, which does not exist in any of the other luxations of the hip, the forward inclination of the body, the flattened state of the buttock, the excessive tension of the iliac and psoas muscles readily felt by the finger, and the impossibility of adducting, extending, and rotating the leg. Another valuable sign is afforded by the great trochanter, which will be found to be farther off from the anterior superior spinous process of the ilium than its fellow on the opposite side.

4. The *pubic dislocation* is so uncommon that it may very properly be classed among the rare forms of the accident. As the name implies, the head of the femur lies upon the horizontal branch of the pubic bone, or, rather, upon this bone and the iliac, fig. 698, above Poupart's ligament, and between the anterior inferior spinous process of the ilium and the femoral vessels, under cover of the iliac, psoas, and straight muscles. The displacement is caused by falls while the limb is pushed backwards and outwards, and there is a heavy load upon the shoulder, as when a man carries a bag of wheat, and his feet suddenly give way under him. Another mode in which it may be produced is by the sudden bending of the body backwards while the foot is implanted in a ditch or hollow and the femur is kept straight by the action of its extensor muscles. Under these circumstances the head of the bone ruptures the upper and inner portion of the capsular ligament, and slips out of its socket into the groin. Mr. Ure, of London, has reported a case in which the dislocation was caused by inordinate muscular contraction in the act of "striking out," as it is termed, in swimming. The man, who felt a peculiar catch in the right groin, which he attributed to cramp, was able to walk, although not without considerable difficulty, after the accident, and the reduction was readily effected by manipulation.

In this luxation, fig. 699, the limb is from half an inch to an inch shorter than the other; the foot and knee are everted, and separated from their fellows, although in a less degree than in the thyroid displacement; the buttock is flattened; the great trochanter lies nearer the middle line than naturally; the femoro-gluteal fold is above its ordinary level; and a distinct prominence, hard, rounded, and easily impressed by moving the leg, exists in the groin, just above Poupart's ligament, representing the head of the femur. Adduction and rotation inwards are impracticable owing to the contraction of the external rotator muscles and the tension of the anterior branch of the ilio-femoral ligament. In a case of

pubic dislocation seen by Physick, in 1805, the head of the bone lay below Poupart's ligament, directly before the acetabulum, the foot and knee were everted, and the limb was a very little longer than the sound one. Larrey has recorded an instance in which the femur projected nearly at a right angle with the body. Sometimes the anterior femoral nerve is pressed upon, causing pain and a sense of numbness along the whole length of the thigh.

Fig. 698.   Fig. 699.

Dislocation on the Pubes.

The flattening of the buttock, the slight shortening of the limb, the eversion of the toes, the impossibility of rotating the thigh inwards, and the existence of the head of the bone in the groin, are marks which sufficiently characterize the accident to prevent mistake.

This luxation is sometimes witnessed at an early age. Erichsen has recorded an instance in a child eighteen months old.

General Diagnosis.—Error of diagnosis in dislocations of the hip-joint can only be avoided by the most careful and thorough examination of the patient, not only once, but, if necessary, repeatedly. It will be well always, in the first instance, to make the patient, properly stripped, stand up, in order to observe what posture he assumes, and what control, if any, he may have over the injured limb. After this has been done, he should be fully anæsthetized, and examined as he lies successively upon his back, his side, and his abdomen, the limb being moved, if possible, in different directions, and measured with a graduated tape to ascertain whether there is any change in its length.

Upon comparing the four varieties of luxations above described with each other, it will be found that, with the exception of the first two, there are sufficiently broad marks of dissimilarity to render the diagnosis, with a little care, very easy. The thyroid is the only one in which there is any lengthening of the limb; in all the others it is shortened, least in the pubic, and most in the iliac. In the iliac and sciatic, the hip is abnormally prominent; in the other two it is flattened; in the former the knee and foot are inverted, in the latter they are everted, decidedly in the pubic variety, and generally very slightly in the thyroid. In all the head of the bone may generally, with a little care and patience, be perceived by the touch in its abnormal position, especially in thin persons, and before the occurrence of much swelling, rolling about when the leg is rotated upon its axis. The great points to be attended to, when there is any doubt in the diagnosis, are, the state of the limb as to the change in its length, axis, and movements; the position of the great trochanter, especially its distance from the anterior superior spinous process of the ilium; and the location of the head of the bone and our ability or inability to feel it in its new

situation. All that is necessary is to give proper heed to these considerations, and any uncertainty that may exist as to the true character of the injury will soon vanish. The investigation will, of course, always be materially facilitated by the use of an anaesthetic.

In the two backward dislocations a satisfactory method of determining the existence or non-existence of the injury consists, as originally suggested by Nélaton, in extending a line from the anterior superior spinous process of the ilium to the most prominent part of the tuberosity of the ischium. This line bisects the acetabulum, dividing it into two equal parts, and at the same time touches the summit of the great trochanter, the thigh being previously flexed at a right angle with the pelvis. If, therefore, the trochanter in any case, projects in a marked degree above this line the fact furnishes conclusive evidence, in the absence of fracture of the neck of the femur, of displacement of the head of the bone. In the sciatic luxation the difference in the length of the thighs, raised at a right angle with the pelvis, affords important information, and is a mode of examination which should never be omitted. The everted position of the limb in the pubic dislocation is, of itself, conclusive evidence of the nature of the case, as the elongation of the limb is in the thyroid. The diagnosis between fractures of the superior extremity of the thigh-bone and dislocations of the hip-joint is pointed out at sufficient length under the head of the dorsal or iliac form of the displacement.

When all the ordinary means, such as the most thorough and patient examination with the touch, sight, and mensuration, fail, the mystery may often be solved with an exploring instrument, inserted at various points of the hip, and moved about in different directions in search of osseous prominences and depressions. A long, slender needle, sinking in to a great depth in the natural situation of the acetabulum, would infallibly declare the absence of the head of the thigh-bone, as the existence of an unusual osseous tumor outside of that cavity would certainly indicate the location of that bone in its new position. As there are no important vessels or nerves in and about the hip, such a procedure would be entirely free from the danger of hemorrhage and even pain. My opinion, however, is that, although perfectly safe and easy, it will rarely be necessary in any case, the nature of the lesion being generally too well marked to elude detection.

Reduction by Manipulation.—The method of reducing luxations of the hip-joint by simple manipulation was occasionally pursued by some of the older surgeons, and it is even dimly shadowed forth in the writings of Hippocrates and Paulus Ægineta; it was distinctly recognized by Wiseman, in the seventeenth century, and successfully practised in the eighteenth by Pouteau, Turner, Anderson, and others; Physick employed it in a case of pubic dislocation, in 1811; its feasibility was taught, for many years, by Professor Nathan Smith, of New Haven, in his annual courses of lectures; and in 1835 special attention was directed to it by Deprès of Paris.

Modern experience satisfactorily shows that all the different dislocations of the hip-joint may, at least in their recent state, be reduced by simple manipulation, not unfrequently even without the aid of anaesthetics. For the full development of our knowledge of this fact we are indebted mainly to Dr. W. W. Reid, of Rochester, through whose agency the operation was first brought into general notice. In a paper, published in 1857, he clearly proved, by a series of well-executed experiments, dissections, and clinical observations, that replacement may nearly always be safely, certainly, and expeditiously effected without any assistants, pulleys, or, in short, any extraneous aid whatever. He erred, however, in supposing that the chief obstacle to restoration was the contraction of the muscles around the hip-joint, more especially those that are put upon the stretch by the malposition of the luxated bone. It remained for Professor Gunn, of Chicago, and Professor Moore, of Rochester, to show that the resistance is due, in great measure, if not exclusively, to the manner in which the untorn portion of the capsular ligament girds the head and neck of the femur; for, whenever this structure was thoroughly divided upon the dead subject, the reduction was generally very easily effected. In the iliac and sciatic forms of the accident an additional obstacle is occasionally presented by the pressure exerted by the iliac portion of the fascia lata upon the great trochanter when the limb is in this unnatural position.

Professor Henry J. Bigelow, in an exhaustive monograph on the "Mechanism of Dislocation and Fracture of the Hip," published in 1869, ascribes the difficulty of reduction exclusively to the resistance offered by the ilio-femoral, or, as he terms it, the Y ligament, which, as is now well known, always remains intact in the regular luxations of this articulation, whereas in the irregular or anomalous, as they are denominated, it is always torn. A similar opinion was enunciated by Von Pitha, of Vienna, in 1865.

The ilio-femoral ligament, hitherto regarded by most anatomists simply as an accessory

ligament to the capsular, or, indeed, as an essential portion of it, is attached, on the one hand, to the anterior inferior spinous process of the ilium, and, on the other, to the anterior intertrochanteric ridge by two fan-like slips, its general outline thus closely resembling the letter Y. Its width, at its origin, is only about half an inch, whereas below it is more than four times that extent. It is remarkably tough and strong, nearly three lines thick at its greatest point of development, and capable, as Bigelow has shown, of resisting a weight of two hundred and fifty to seven hundred and fifty pounds. The annexed sketch, fig. 700, affords a graphic illustration of the form, situation, and attachments of the ligament, as delineated in the work above mentioned.

Fig. 700.

Ilio-femoral Ligament.

The process of reduction consists of certain stages and evolutions, in which the shaft of the femur is employed as a lever, and the pelvis as a fulcrum, the object being, in the first instance, to dislodge the bone from its new situation, and then to induce the muscles to assist in drawing it into place, compelling it thus, as it were, to retrace its steps along the route travelled in the dislocation. In conducting the operation, the best plan is to make the patient lie upon the floor, as this affords a much firmer base of resistance than a lounge, bed, or table, and likewise gives the surgeon an opportunity of placing himself in any position that may be deemed advisable. Complete anæsthesia should be induced; and, if the patient be unusually stout and plethoric, blood may advantageously be taken from the arm, as a preliminary measure, although this will seldom be required. In the female, exposure of the person is avoided by means of a sheet. Everything being ready, the surgeon, grasping the knee with one hand, and the leg immediately above the ankle with the other, flexes the thigh upon the pelvis and the leg upon the thigh, such a step being absolutely necessary to relax the capsular and iliofemoral ligaments. The thigh, in the iliac displacement, is carried across its fellow at the union of its middle and upper third, and then simply rotated outwards. In the sciatic variety, the reduction is effected in a similar manner, with this difference, that the limb is lifted, as a preliminary step, high up across the opposite groin. In the thyroid luxation, the thigh, raised to a right angle with the pelvis, is, at first, abducted, and then strongly rotated inwards. In the pubic form of the accident, the thigh, after being elevated in the usual manner, is, in the first instance, abducted and drawn downwards, and then rotated inwards. In the "everted iliac" dislocation, the limb, as a preliminary step, is placed by flexion and rotation inwards in the position which it assumes in the ordinary form of the accident, when the reduction is effected in the usual manner, aided, if necessary, by adduction.

Mr. Morris, in the posterior luxations, effects reduction, after flexing the thigh, by rotating and circumducting the limb outwards; and in the anterior, after flexing the thigh, by abducting slightly and strongly circumducting and rotating inwards. In other words, in each set of cases, reduction, says Morris, "is effected, after first abducting the thigh, by rotating the head of the femur in the opposite direction to that in which it was rotated during dislocation, and in all cases the leg is flexed to relax the hamstring muscles and the sciatic nerve. In this way the head of the bone is brought below the acetabulum and rotated back again into that cavity, not simply on the side where the acetabular margin is less prominent, but where, also, a passage exists through the capsular ligament." The rim of the acetabulum does not often, Morris thinks, offer any actual resistance to reduction; but he considers it important to lift the head of the femur away from the innominate bone during flexion and abduction, in order the more readily to disengage that prominence from the sciatic nerve which is not unfrequently partially twisted around it.

Professor Bigelow, after having thoroughly relaxed the ilio-femoral ligament, the chief point of resistance in these luxations, by flexion of the thigh and leg, employs either rotation or vertical traction, the direction of the movement being regulated by the form of

the displacement. If the opening in the capsular ligament is too small to admit of easy reduction, it may readily be enlarged, as a preliminary measure, by circumducting the limb in a direction opposite to that in which it is designed to carry the head of the bone. For making vertical extension, which affords the most complete relaxation of the ilio-femoral ligament, Bigelow employs the tri-

Fig. 701.

Bigelow's Tripod for Vertical Extension.

pod, represented in fig. 701, the pelvis being secured to the floor by a padded band. Rotation may be effected by means of the transverse rod above the knee, while the head of the femur is carried from the dorsum of the ilium or the pubes in the direction of the tuberosity of the ischium by vertically raising the longitudinal rod attached to the calf of the leg. Such a contrivance is, of course, only adapted to hospital practice.

In old dislocations, additional obstacles to reduction exist, depending upon the rigid and contracted condition of the muscles of the hip and the adhesions formed by the plasma effused in consequence of the injury sustained by the affected structures. The period at which these impediments attain their full force must, of course, vary in different cases and under different circumstances. In an iliac luxation of one month's duration, under my charge, in 1855, in a very stout, muscular young man, I promptly succeeded in effecting replacement by simple manipulation, after complete failure with the pulleys employed for nearly an hour and a half, the patient being all the while thoroughly relaxed by chloroform. In 1863, at the College Clinic, I was equally fortunate, in a similar dislocation of twenty-seven days' standing, in a lad fourteen years of age. Successful examples of much longer duration have occurred in the hands of other surgeons.

In the pubic and thyroid dislocations, reduction has occasionally been effected by the heel in the perineum, the patient and surgeon lying in opposite directions, as in luxations of the shoulder. The pelvis being thus firmly fixed by the foot, extension is made by grasping the leg above the ankle, the limb being gradually carried over the sound one as the head of the bone approaches the cotyloid cavity. Or, instead of this, the leg may be flexed at a right angle with the knee, and a long, stout noose secured around the lower part of the thigh, and thrown over the operator's neck and shoulder, which will thus afford him much greater control over the limb. This method, however, which recommends itself by its simplicity, is chiefly applicable to very thin, feeble subjects, offering but little muscular and ligamentous resistance.

The late Dr. Brainard, of Chicago, in four cases of thyroid dislocation, promptly succeeded in effecting reduction by placing a piece of well-padded wood, four inches and a half in diameter, as a fulcrum, in the perineum, between the thighs, which were then used as levers, the limbs being extended during the operation, and the affected one carried slightly across the sound one. Occasionally a bedpost has been used for a similar purpose; but, in employing such an expedient, care must be taken not to raise the leg, otherwise the head of the femur may be thrown into the sciatic notch.

An old pupil of mine, Dr. George Sutton, of Indiana, has succeeded in reducing five cases of luxation of the thigh at the hip, four iliac and one sciatic, by placing a cloth cylinder, three inches in diameter, and from twelve to fifteen inches in length as a fulcrum, in the groin, and using the leg as a lever to lift the head of the bone over the rim of the acetabulum. The plan, it will be perceived, is similar to that adopted by some surgeons in reducing dislocations of the shoulder-joint.

Reduction with the Pulleys.— When manipulation fails, as it occasionally will, especially in very stout, robust persons, and in chronic cases, recourse must be had to the pulleys, for then even severe measures would be preferable to leaving the luxation unreduced.

and letting the patient remain a cripple for life. The general principles which should guide the practitioner in the use of these instruments have already been pointed out. I shall, therefore, limit myself here to a brief description of the operation as applicable to the several varieties of dislocations of the hip, premising that the employment of the pulleys, is, at best, an expedient of doubtful efficacy, often productive of much greater harm than benefit.

The patient should be laid upon his back on the floor, or on a firm table, lounge, or bed, between two strong objects, from ten to twelve feet apart, in each of which a large hook is fixed. A stout, soft piece of muslin, neatly folded, and at least four yards in length, is placed in the perineum, and being carried over the groin and buttock, its ends are tied together, and fastened to the hook behind the patient's head. Another band is carried around the upper part of the pelvis, and given to an assistant, to prevent the injured hip from being drawn down during the operation. Finally, a large wet towel is rolled around the lower part of the thigh, and over this is buckled a leather band with two lateral straps, each provided with a ring. Or, instead of the band, a stout fillet is employed, being fastened by means of a wet roller, or the French knot, the ends being so disposed as to come down on each side of the knee, a little below which they are to be tied. Best of all for this purpose is the contrivance delineated at p. 1111. The knee being now bent nearly at a right angle, and inclined a little across its fellow, the pulleys, secured to the extending band and the staple, are put in motion by gently drawing the cord. As soon as the apparatus is thoroughly put upon the stretch, and the patient begins to evince symptoms of suffering, as he will be sure to do if he has not taken an anæsthetic, the efforts are to be relaxed, to allow the muscles a little rest. After having waited a few minutes, the cord is again tightened, to increase the tension somewhat, when the efforts are to be again intermitted. Taking care to proceed in this slow, gentle, and gradual manner, until the head of the femur has reached the edge of the acetabulum, the surgeon intrusts the management of the cord to an assistant, while he himself, grasping the upper part of the leg, rotates the limb in a direction contrary to that of its displacement, and thus promotes the return of the bone to its socket, the reduction being generally indicated by a distinct snap. When the head of the bone hitches against the rim of the acetabulum, its disengagement may be materially facilitated by means of a fillet placed around the groin, and thrown over the operator's neck and shoulder, so as to enable him to lift the bone up to a level with the cotyloid cavity, into which it will then be drawn by the contraction of the muscles. The length of time during which the action of the pulleys is maintained must depend upon circumstances, the restoration, in some cases, being effected in a few minutes, in others not under several hours, if at all.

The annexed cut, fig. 702, illustrates the position of the patient during the operation, the arrangement of the pulleys and the extending bands, and the position of the limb.

Fig. 702.

Reduction of the Iliac Dislocation with the Pulleys.

In the iliac and sciatic dislocations the rule is to let the patient lie on his back, and after the extension and counterextension have been kept up for some time, to carry the affected limb across the opposite one, as this enables the head of the bone the more easily to disengage itself from the brim of the pelvis. In the thyroid and pubic varieties the extension is directed downwards and backwards, the foot of the affected limb being carried behind the sound one, and the patient lying upon the uninjured side. The manner of conducting the proceeding is represented in figs. 703 and 704.

Fig. 703.
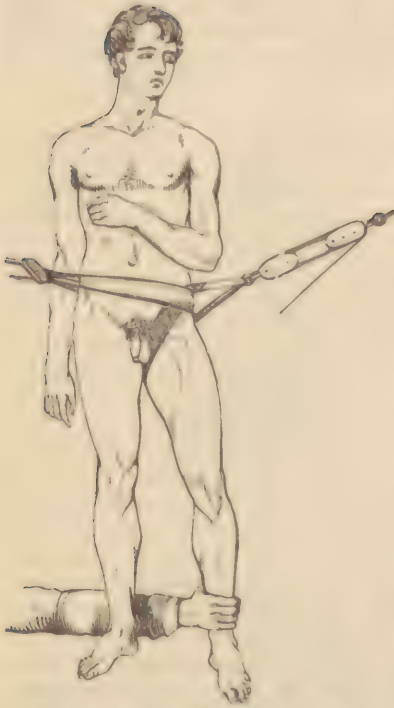
Reduction of the Thyroid Dislocation.

In the attempts at reduction, the head of the bone, instead of returning to its socket in the act of being lifted out of its abnormal position, occasionally drops into some other, from which it may, perhaps, be more difficult to dislodge it than it was in the first instance. This accident is most liable to occur in the iliac luxation, which, as the head of the femur is moved about to disengage it from the iliac fossa, is readily converted into the sciatic. In a case reported by Dr. F. D. Lente, the head of the bone was thrown from the sciatic notch upwards under the anterior superior spinous process of the ilium. Occasionally the pubic displacement is changed into the thyroid; and an instance happened at the Pennsylvania Hospital, in the service of Dr. Neill, in which, during the reduction, the bone was thrown out of the thyroid foramen into the sciatic notch, from which it was afterwards returned with great difficulty by means of the pulleys. These accidents are generally unavoidable; but a knowledge of the possibility of their occurrence should put the surgeon upon his guard, that he may not be deceived under an idea that he has effected reduction when he has only succeeded in producing another displacement.

When the head of the bone has resumed its original position, as may always be known by the disappearance of the symptoms, and by a comparison of the limb with its fellow, a return of the accident is to be prevented by the observance of recumbency for at least three weeks, and by keeping the thighs close together by means of a bandage applied just above the knees during nearly the whole of this period. During the first eight or ten days the hip should be constantly covered with cloths wrung out of a strong solution of acetate of lead and laudanum. If the inflammation run high, leeches,

Fig. 704.

Reduction of the Pubic Dislocation.

active purgation, antimonial and saline preparations, and even general bleeding, may be demanded. After the morbid action has measurably subsided, sorbefacient lotions, and passive motion of the joint will be required, to promote the removal of plastic matter, and to prevent ankylosis.

It is seldom that any of the luxations of the hip recur after the bone has been properly replaced, for such are the depth of the acetabulum and the nice adaptation of the head of the femur as to render an event of this kind extremely difficult after recovery from the immediate effects of the injury. A remarkable instance, however, occasionally occurs, in which the same displacement happens again and again, in more or less rapid succession, in the same person. Thus, Mr. John F. South gives the case of a woman, who, in thirteen years, dislocated her femur upwards and backwards upon the ilium not less than twenty-one times; latterly from so trivial a cause as stooping, or turning in bed. The

accident originally happened when she was twenty-four years old, from slipping on a piece of orange peel. In this case the frequent recurrence of the displacement was doubtless due to extensive rupture of the ligaments of the joint; but now and then it is found to depend upon fracture of the border of the cotyloid cavity. However induced, the accident is always to be deplored, because it is generally irremediable.

Cases occasionally occur in which these dislocations are complicated with fracture of the superior extremity of the femur, rendering it extremely difficult, if not impossible, to effect reduction by any means that can be adopted. In such circumstances the most plausible plan would seem to be to attend to the fracture first, and after that has become consolidated, to attempt the restoration of the displaced bone in the usual manner. In some instances in which this practice was pursued the result was all that could be desired.

ANOMALOUS DISLOCATIONS OF THE HIP-JOINT.

The hip, like the shoulder, is subject to certain forms of displacement, to which, from the infrequency of their occurrence, the term rare, irregular, or anomalous may be applied. They are perhaps, for the most part, merely exaggerated states of the more ordinary varieties of the accident produced, as Professor Bigelow has shown, by the rupture of the ilio-femoral ligament. The annexed account comprises a succinct outline of the principal reported cases. In a majority of these the head of the femur was thrown downwards against some portion of the ischium; in one it was lodged in the perineum, and in one it was pushed upwards and inwards against the ilium, lying in the space between the two anterior spinous processes.

α. Mr. Robert Keate observed a case in which the head of the bone lay close to, and on a level with, the tuberosity of the *ischium*, where it could be distinctly felt rolling under the finger on moving the thigh, which was more than three inches longer than natural, much flexed upon the pelvis, and widely separated from the sound one. The leg was greatly bent, the foot much everted, and the large trochanter extremely sunk. By drawing the upper part of the femur outwards, and pressing the knee sharply inwards, the head of the bone returned to its proper place with a decided snap. Immediately afterwards, however, the limb could be elongated by slight traction, inducing the belief that a portion of the cartilaginous rim of the acetabulum had been broken off in the accident, which had been caused by the man falling from his horse into a deep, narrow ditch, the animal tumbling backwards upon him.

β. In a case described by Mr. Wormald, the head of the femur rested upon the upper part of the *tuberosity* of the ischium, above the quadratus muscle. The accident, caused by a leap from a third-story window, was attended with other injury, which soon proved fatal. The head of the bone was easily recognized in its new situation. The limb, considerably shortened and inverted, formed half a right angle with the body, and the shaft of the femur, crossing the pubic symphysis, was immovably fixed in this position.

γ. Mr. Earle and Mr. Adams have each recorded an example in which the head of the bone lay upon the *spine* of the ischium. In the former the limb was lengthened about half an inch, but there was neither eversion nor inversion; the trochanter was farther back and less prominent than natural; an extraordinary vacuity existed in front of the hip; and the outline of the sartorius and tensor muscles was uncommonly distinct, their edges being tense and almost sharp. In Mr. Adams's case the limb was inverted, and could not be rotated outwards when the knee was extended, nor abducted when the knee was flexed. Slight shortening existed.

δ. Dr. Kirkbride met with an instance in which the head of the femur was thrown upon the posterior part of the *body* of the ischium, between the tuberosity and the spine. The thigh lay across the sound one, the leg was flexed, the limb was lengthened at least an inch, and the interval between the great trochanter and the anterior superior spinous process of the ilium was much increased. Rotation was difficult, and extension impossible. The head of the bone was easily felt. The accident was caused by a fall from a considerable height, in which the body was crushed by a heavy piece of timber. The reduction was effected by the pulleys, but not without difficulty, for the man was very muscular, and the bone was firmly impacted in its new situation.

ε. In two cases seen by Dr. J. M. Warren the head of the bone rested against the ascending *ramus* of the ischium, the thigh projecting out laterally at a right angle with the trunk. A deep hollow existed at the spot naturally occupied by the great trochanter. The reduction was effected, in one of the cases, by manipulation; in the other, by the pulleys.

ζ. Dr. Willard Parker has reported a case of dislocation of the femur into the *perineum*, in a man, thirty-five years of age, who was injured by the fall off a boat, his body being at the moment bent strongly forwards and his feet separated. The limb projected at a right angle with the trunk, the buttock being flattened, and the toes turned slightly inwards; and the head of the bone, upon rotating the thigh, could be distinctly felt in the perineum behind the scrotum, near the bulb of the urethra. The reduction was readily effected by confining the pelvis and extending downwards and outwards, aided by moderate rotation. In this way the head of the bone was made to ascend over the ramus of the pubes into the thyroid foramen, from which it was afterwards conducted into the acetabulum by carrying the limb across the sound one.

η. A case similar to the above occurred to the late Dr. Charles Pope, of St. Louis, in a man, forty years of age, who had his body crushed by the caving in of a bank of earth, as he was standing in a bent position, with his limbs widely separated. The thigh, inclined somewhat forwards, formed a right angle with the body, and the head of the bone lay under the skin of the raphe of the perineum. The accident was associated with fracture of the leg and arm. Reduction was effected with the pulleys, the bone returning with a loud snap.

θ. Several cases have been observed in which the head of the femur was dislocated upwards and inwards into the space between the two anterior *spinous processes*. In one, examined by Mr. Morgan, the bone, lying in this precise spot, could be distinctly felt under Poupart's ligament, upon the brim of the pelvis. The prominence of the great trochanter was entirely lost, the thigh was shortened at least two inches, the toes were excessively everted, and the injured limb had a tendency to cross the sound one. Rotation was impossible, but all the other motions could be performed, although only in a limited degree, and not without great pain. Reduction was easily effected. A similar case has been described by Mr. Travers, caused by a fall, from a height of twenty feet, in which the left buttock struck upon a coil of chain cable. Here, however, the neck, and not the head of the bone, lay between the two anterior spinous processes, the head not being perceptible. The left buttock was flattened, and the limb, shortened and everted, had the appearance, when the patient stood erect, of being suspended from the anterior and lateral part of the ilium. A little below and to the outer side of this point was the great trochanter, easily distinguishable by the finger.

ι. In a case described by Mr. Luke, the head of the bone was lodged midway between the thyroid foramen and the sciatic notch, immediately beneath the lower border of the acetabulum. The limb was lengthened one inch, without eversion or inversion, and the head of the bone was easily felt in its new position. The reduction was accomplished without difficulty. The man dying from the effects of other injuries, the dislocation was reproduced in the dissection of the joint. The inferior gemellus and square femoral muscles had been torn, the lower part of the capsular ligament had given way, and the round ligament was completely detached. The patient, a stout man, fifty years of age, had been hurt by a fall into a dry-dock.

κ. Finally, Dr. W. E. Hodder, of Toronto, has recorded the case of a man, twenty-two years of age, in which the head of the femur was thrown under the *arch of the pubes*, by a large quantity of earth falling upon the loins and hips. The bone could easily be distinguished in its abnormal position, and the thigh, as the patient stood up, formed nearly a right angle with the trunk. The knee was everted, a remarkable concavity existed upon the dorsum of the ilium, the psoas and iliac muscles were very tense, and the great trochanter could scarcely be felt. The affected limb was, if anything, a little longer than the sound one.

The above cases may be regarded as types of most, if not all, of the forms of anomalous dislocations of the hip-joint. The symptoms are usually prominent, if not positively characteristic. The treatment must be conducted according to the general principles which guide the surgeon in the management of the ordinary varieties of the accident. Manipulation alone will frequently suffice to effect reduction, as there is always necessarily extensive rupture of the soft parts; when greater force is required, the pulleys must be employed. In some of the cases here mentioned, the restoration was effected by a kind of compound process, the dislocation being first changed into a common one, from which the head of the bone was afterwards returned to its natural position by a secondary effort.

PARTIAL AND COMPLICATED DISLOCATIONS.

The possibility of a partial dislocation of the hip-joint is still a debated point. Malgaigne admits the possibility, and adduces cases in illustration of it. Professor Hamilton thinks he has met with two examples of it; and, many years ago, Dr. J. C. Warren saw one, in a child six years old, which has also been referred to this class of injuries. If we define, as in strictness of language we must, a partial dislocation to be one in which the articular surfaces of this joint still partly retain their natural relations, it is extremely questionable whether such an occurrence is possible, as a purely traumatic accident; as a result of disease of the head of the femur, of the borders of the acetabulum, or of the ilio-femoral ligaments, it is easy enough to admit it.

Subluxation of the femur is an occasional occurrence; a lesion in which the person possesses the faculty of voluntarily throwing the head of the femur out of place, and at the same time of reducing it by his own unaided efforts. A considerable number of such cases are upon record. Portal was, perhaps, the earliest writer to draw attention to it. The accident has hitherto been noticed chiefly in young and middle aged men, very few instances having been observed in women. The most common form of the dislocation is the iliac. The affection in some instances is congenital; in others it has evidently been the result of external injury, and in all it is accompanied by more or less relaxation of the ligaments. A few years ago a contortionist exhibited himself in this city, who could voluntarily dislocate nearly all the movable articulations in his body. Many of the subjects of this affection are more than ordinarily muscular. It does not seem that such cases require any surgical treatment or mechanical support.

Dislocations of the hip-joint are sometimes complicated with fracture of the femur; the occurrence, however, is very uncommon, and is chiefly of interest in reference to the restoration of the parts, which should always, if possible, be effected by manipulation instead of by extension and counterextension. Dr. James Douglas has reported a case of luxation upon the pubes accompanied with fracture of the neck of the femur, the superior extremity of which was found after death, twelve years after the receipt of the injury, in the groin, on the inside of the femoral vessels. The head of the bone still remained in its unnatural position. The reduction of such a dislocation must necessarily, one would suppose, be attended with immense difficulty, and yet it would seem, from experiments performed by Richet upon the dead subject, that this is not the fact. He ascertained that, by luxating the femur and then dividing the neck of the bone, so as to imitate a fracture, he could easily push the head into its socket. When the femur is broken in its shaft, the limb, as a preliminary step, must be firmly put up in splints, otherwise it will be impossible to obtain a proper leverage for executing the requisite manipulations. Examples of successful reduction under such circumstances have been reported by different observers, among others by Bloxam, Birket, Eténe, and Oscar Allis.

Dislocations of the hip-joint, complicated with fracture of the acetabulum, are always serious accidents. Cases occur in which the head of the bone is pushed through the bottom of this cavity into the pelvis, inflicting great, if not fatal, injury upon its contents; and specimens are to be seen in different museums, where the floor of the acetabulum was broken into numerous fragments by violence sustained in this way. The rim of the acetabulum is occasionally chipped off by the head of the femur, especially in the iliac and sciatic forms of luxation, and, in such an event, it is always very difficult, if not impossible, to retain the parts in their natural relations after replacement. The best plan, after reduction, is to keep up permanent extension by means of a weight attached to the foot, and to support the affected joint with a broad belt passed around the pelvis.

Severe injury is sometimes inflicted upon the sciatic nerves, as in the sciatic form of dislocation, by the pressure of the head of the femur. In such an event there must necessarily be more or less numbness in the corresponding limb, occasionally attended with partial paralysis. In a case observed by Mr. Hutchinson, of London, the paralysis was permanent.

CHRONIC DISLOCATIONS.

Chronic dislocations of the hip-joint are occasionally brought under the observation of the surgeon, and the question, therefore, necessarily arises, when should such displacements be considered as irreducible? It has been seen elsewhere that Sir Astley Cooper asserts that, as a general rule, it is imprudent to attempt restoration after the eighth week, except in persons of a debilitated frame, or very lax habit of body; and most English and American surgeons, adopting this view, have inculcated similar precepts. I believe this

opinion to be in the main correct, and it may even be assumed that there are not a few cases which will resist all efforts at reduction long before the expiration of this period. In an especial manner is this true of the dislocations backwards into the sciatic notch and downwards into the thyroid foramen, in which the head of the femur becomes much sooner firmly and immovably fixed in its new position than in the iliac and pubic varieties. Sir Astley Cooper himself admits the existence of exceptions, and he has published the particulars of a case of luxation, upon the dorsum of the ilium, reduced after the lapse of five years. Numerous instances of a similar purport, only of much shorter duration, have been narrated by other writers, all tending to show that there are circumstances in which reduction may be hoped for after a joint has been out of place for several months.

It is not necessary to repeat here what has elsewhere been insisted upon in regard to the considerations which should influence the surgeon in the choice of his cases; or, in other words, the circumstances which should induce him to attempt or decline interference. Full instruction has already been given upon this subject, and yet, in view of its paramount importance, it may not be amiss to subjoin a few remarks, if it be only for the purpose of insuring greater care and caution.

The circumstances which may usually be considered as forbidding any efforts at restoration are, first, the absence of mobility in the luxated bone; secondly, occlusion of the acetabulum by fibrinous deposits; and, thirdly, great disorder of the general health, rendering it probable that the system could not withstand the shock and irritation following the operation.

The first of these points can usually be determined by moving the limb about in different directions, and watching the degree of displacement suffered by the femur. The examination should be conducted by taking hold of the knee, or, better still, of the knee and ankle, and it will be most efficient if while the limb is rotated, or attempted to be rotated, the hand be applied to the head of the luxated femur. When there is no motion, or motion only in a limited degree, it may be assumed that the adhesions are too strong to admit of rupture without risk of serious injury to the parts.

It is not always, indeed not generally, easy to determine whether the acetabulum has been filled up or not by plastic deposits. The probability of such an occurrence may be inferred if the accident have been followed by severe inflammatory action, if the parts have ceased to be tender on pressure, and if the head of the bone have contracted firm adhesions to the surrounding tissues. If any doubt remain, the exploring needle might be used, its point being carried about in different directions, to ascertain the amount and consistence of the obstructing substance.

It may be stated that, other things being equal, the acetabulum will be filled up much sooner in young, robust subjects than in the aged and feeble, and that, as a general rule, the likelihood of its being so is always in proportion to the length of time that has elapsed since the occurrence of the displacement.

Finally, the patient's health may be so much reduced as imperatively to prohibit all attempts at reduction, not on account of any pain that might be experienced, for chloroform would effectually prevent that, but because so much violence might be done in the operation as to cause the most intense inflammation and constitutional irritation, placing life in imminent peril.

When it is deemed advisable to undertake the treatment of such cases, it will generally be necessary to use the pulleys, subject to the rules and regulations already laid down for their employment; but sometimes the object may be readily be attained, or at all events, without much difficulty, simply by manipulation. Thus, Dr. Dupierris, of Havana, and Dr. Blackman, of Cincinnati, each met with an instance of iliac luxation of six months' standing, in which they succeeded most satisfactorily by this method alone; and a number of similar cases have occurred in the practice of other surgeons. Dr. Sayre effected the reduction of a sciatic luxation by manipulation at the end of nine months; and Dr. Smyth, of New Orleans, was equally fortunate in a case of the iliac form of the accident at the end of this period. Such examples are full of instruction, and deserving of the most attentive consideration, conveying, as they do, a highly valuable practical lesson. Nevertheless, they must be regarded merely as so many exceptions to a general rule, and nothing more.

Finally, instances have occurred, as those observed by Physick, Travers, Randolph, Malgaigne, Blackman, Wood, and Prince, in which, in an attempt to reduce an old dislocation of the hip-joint, the femur gave way at its neck, within the capsular ligament. Sometimes violent inflammation, abscess, pyæmia, and death, have followed the accident. Occasionally a more fortunate result ensues, the fracture of the bone being eventu-

ally succeeded by a good use of the limb, as in the case of a man between thirty-five and forty years of age, whom I attended along with a former colleague, Professor Joseph Pancoast. The head of the femur lay upon the iliac bone, the displacement having occurred nearly three months previously. There was great lameness, accompanied with much deformity, and, as the patient was very anxious for relief, he was accordingly anæsthetized and subjected to the use of the pulleys, as well as to manipulation. During the progress of our efforts, the bone suddenly broke at its neck, with the result of a very good use of the limb, the patient being able in a few weeks to move it in every direction, instead of being obliged to hold it in the stiff and unseemly position which it had been previously. The shortening did not exceed two inches.

Although it might not be advisable to adopt such a procedure as this as a rule of practice, it is worthy of consideration whether, in cases of irreducible dislocations, attended with great deformity, and a useless condition of the limb, it would not be proper. The patient here alluded to experienced no serious inconvenience from the accident, and the result was certainly highly gratifying. It is to be borne in mind that, from the softening which the articular extremities of the bones undergo in old and neglected luxations, such a fracture is a comparatively easy and simple occurrence, not necessarily followed by severe inflammation. Without such an effort, it is evident that the patient must remain a cripple for life. Instead of fracturing the neck of the bone, however, a safer and better plan is to divide it subcutaneously with an Adams's saw. A case of old irreducible thyroid dislocation, in which the head of the femur was excised, has been reported by MacCormac, of London.

CONGENITAL DISLOCATIONS.

Congenital luxation of the hip-joint is very uncommon. Females are more liable to it than males, and it is also more frequent in scrofulous than in healthy children. Of 107 cases reported by Pravaz, in 1884, only 11 were males. Of these cases 51 were double; the right hip alone was affected in 28, and the left in 24. The immediate causes of this variety of displacement are, first, shortness, total absence, or extreme obliquity of the neck of the thigh-bone; secondly, partial or entire obliteration of the cotyloid cavity; and, thirdly, deficiency, extraordinary elongation, or complete absence of the round ligament. The capsular ligament is frequently elongated and relaxed, and the head of the femur is occasionally materially diminished in size.

The malformation consists in shortening of the affected limb, unnatural projection of the great trochanter, ascent of the head of the femur into the iliac fossa, inversion of the leg, and obliquity of the pelvis. The motions of the joint, particularly those of abduction and rotation, are constrained and imperfect; the muscles of the upper part of the thigh are retracted, or drawn towards the iliac crest; the limb is thin, wasted, and out of all proportion to the rest of the body; the tuberosity of the ischium is almost uncovered, and, consequently, unusually prominent; the upper part of the trunk is thrown backwards, while the lumbar portion of the spine projects forwards, being concave behind; the pubes is placed almost horizontally on the thighs; and the ball of the foot alone touches the ground when the child stands erect.

In the recumbent posture, when the weight of the trunk is taken off, and the muscles are relaxed, most of the symptoms of luxations disappear, and the limb may be shortened or elongated at pleasure. In walking, the body is inclined towards the sound side, and the head of the dislocated bone sinks towards the cotyloid cavity by its own weight. As age advances, the limb becomes shorter, the femur ascending higher and higher on the ilium; the obliquity of the pelvis augments; and the power of locomotion, already so much impaired, is completely destroyed.

Congenital dislocation of the hip-joint may generally be easily distinguished from other accidents or maladies, by the affection being observed at or soon after birth; by the obliquity of one or both thighs; by the absence of pain, swelling, and ulceration; and by the head of the femur being displaced without any external violence; and by the ability of the surgeon to lengthen or shorten the limb at pleasure. In disease of the hip there is always more or less pain, with a feverish state of the system, and gradual failure of the strength; the parts about the joint are tense and swollen; the limb, at first somewhat lengthened, becomes afterwards shortened, and cannot be extended without the greatest suffering; and the motions of the ilio-femoral articulation are permanently impaired.

The pathological appearances vary. In general, the cotyloid cavity is partially obliterated, or entirely deficient, being replaced by a small, irregular osseous prominence, de-

void of cartilage and synovial membrane; the head of the femur, often flattened at its antero-internal aspect, rests in a kind of superficial fossa on the dorsal surface of the ilium; the round ligament is elongated, partially worn away, or even altogether absent; and the surrounding muscles are either atrophied, transformed into a yellowish, fatty, fibrous tissue, or preternaturally developed. In the latter case, their action is preserved; in the former, it is very much restricted, if not totally abolished.

The *treatment* of congenital dislocation of the hip-joint can seldom be anything more than palliative. In cases of recent standing, permanent extension, by means of a common fracture apparatus, or some other suitable contrivance, may be tried with a prospect of advantage. When both joints are involved, the patient should be kept for a long time in the recumbent posture, in order to take off the weight of the body from the limbs, as this is the main agent in aggravating the displacement. As an important auxiliary measure, the shower-bath, followed by dry friction, or friction with ammoniated and other stimulating liniments, may be employed. The pelvis may be encircled with a broad, well-padded belt, so as to steady the trochanters, and counteract the tendency of the thigh-bones to ascend towards the iliac crests. If debility exist, tonics will be required, especially quinine and some of the preparations of iron.

Mr. Broadhurst, of London, recently, in a case of this kind, divided all the muscles that are inserted into the great trochanter, brought down the limb, and held it in this position for six weeks, at the end of which the patient was able to walk without the aid of artificial support. All attempts to create a new socket for the displaced bones must be futile, notwithstanding what has been said to the contrary.

END OF VOL. I.